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Looking smart is not the ultimate goal: An examination of a gifted and talented science program

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LOOKING SMART IS NOT THE ULTIMATE GOAL: AN EXAMINATION OF A GIFTED AND TALENTED SCIENCE PROGRAM

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USE OF THESIS

ABSTRACT

At Metropolitan High School (MHS) a gifted and talented science program (GTSP) operates to meet the educational needs of exceptional students. Academic achievement is dependent on many factors including cognitive ability, goal orientation, self-regulation of learning and self-efficacy. Few studies have attempted to investigate the significance of each of these in special populations particularly in the academic field of science. The literature indicates that educational programs should be subject to evaluation, yet such evaluation is not routinely carried out.

In a balanced teaching system, components such as curriculum, teaching methods, assessment procedures and classroom environment are aligned so that they complement each other to create the desired outcomes. The aim of this research was to investigate whether components of the GTSP were aligned to promote a deep approach to learning and the use of self-regulated learning strategies which are important intrapersonal catalysts in Gagné's model of giftedness and talents.

In the pragmatist paradigm, quantitative and qualitative data forms were utilised to allow methodological triangulation to enhance the rigor of the research process. The research was an exploratory, parallel, nested, mixed model study. Data were integrated at the analysis phase to examine the GTSP, the object of the case study.

Within the GTSP best practice education for the gifted was balanced against the requirements of the MHS science curriculum. GTSP students demonstrated high level outcomes in school, state and national measures of science achievement despite the fact that participation in the GTSP did not facilitate a significant increase in deep learning.

In order to promote deep learning, self-regulation and the high achievement of GTSP students into the future, it is recommended that the assessment practices within the GTSP are reviewed and aligned with best practice education for the gifted.

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

(i) incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher education.

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CHAPTER 1

INTRODUCTION AND CONTEXT

This introduction describes what the research is about, provides a rationale for conducting the research and explains the background and context in which the research took place. The research purpose and research questions are stated. Since the boundaries of the conceptual framework shown in Figure 2.12 were affected by the Researcher’s background in education, the personal historical context of the Researcher was included, along with a statement of the Researcher’s position on special education for the gifted and talented.

Background and Context

Metropolitan High School (MHS) is a large, government funded high school established in 1963 in Perth, Western Australia. The school currently has a student population of about 1400, the majority of whom are drawn from the relatively high socio-economic suburbs that surround the school. In 2003 MHS introduced a gifted and talented science program (GTSP). Students are selected for the program on the basis of results on a test constructed by the Australian Council for Educational Research (ACER). During the period of data collection for this research (2006-2007), there were two GTSP science classes in Year 8 (age 13), Year 9 (age 14) and Year 10 (age 15). The research was longitudinal in nature, focusing specifically on a group of Year 8 students as they entered the GTSP at MHS and proceeded through Year 9.

Since 1998 all government schools in Western Australia, including MHS, have been required to implement teaching and learning programs for students from kindergarten to Year 10 consistent with the Curriculum Framework (1998). The Curriculum Framework outlines the outcomes that students should achieve as a result of their schooling in eight learning areas, including science. The foundation of contemporary educational change at the heart of the outcomes based curriculum in

Western Australia is the pedagogy of constructivism. Accordingly, teachers within the GTSP are constructivist teachers selected on the basis of their pedagogical content knowledge by the MHS coordinator of gifted and talented programs. These teachers have appropriate and well developed skills for designing formative assessment tasks that are challenging and motivating. A constructivist teacher acknowledges that each student comes to class with their own prior knowledge that is modified by learning experiences and reshaped by social interaction. Such teachers extend learning into different contexts and enhance self-regulation of learning including metacognition (Baeten, Dochy, & Struyven, 2008; Gunstone, 1995; Pritchard, 2005; Roth, 1999; Smee, 2005; Yoon, 2009).

GTSP teachers also recognise that just as provision is made for students with learning difficulties, there is an obligation to ensure a quality education for gifted and talented students (Park & Oliver, 2009). Within the Curriculum Framework, attention is drawn to inclusivity which "means recognising and accommodating the different starting points, learning rates and previous experiences of individual students or groups of students" (Curriculum Council, 1998, p. 17). The Department of Education and Training of Western Australia acknowledges that access to specialised classes may be necessary to ensure that all students are given the opportunity to achieve intended outcomes at an appropriate rate and level (Curriculum Council, 1998).

Within the GTSP at MHS, pretests are used to determine the levels the students are working at in relation to each science outcome. Since the GTSP students are required to sit identical common assessment tasks given to other classes, curriculum design for them involves compaction and differentiation (Macleod, 2005). Compaction involves looking closely at the curriculum in the light of student prior knowledge and carefully sequencing concepts to facilitate the change "from private, scientifically unacceptable knowledge to public, scientifically acceptable knowledge" (Prain & Hand, 1995, p. x). A student's private knowledge is not considered to be incorrect (or a misconception) as it has been personally constructed and is valid for that individual even though it may not be scientifically acceptable knowledge. Compaction allows the teacher to introduce new ideas whilst minimising the time spent on concepts already mastered. Differentiation, which requires sophisticated pedagogical skills, addresses the different learning approaches, styles and rates of learning of gifted students (Macleod, 2005; Park & Oliver, 2009). Inclusion of more individualised tasks, including open-ended science investigations, allows students to explore their own areas of interest and afford flexibility of presentation (West, 2007); such tasks also assist in the development of students' self-regulatory skills (Yoon, 2009).

Accomplished teachers work to establish more effective ways for students to learn by combining theory and practice. Student understanding involves a student relating to a concept in the way an expert does (Ramsden, 2003; Rayneri, Gerber, & Wiley, 2006). Effective teaching encourages a deep approach to learning and discourages students from using a surface approach (Bain & Zimmerman, 2009; Biggs, 2003). When using a deep approach, students use the full range of learning activities, for example, they might memorise facts, but then go on to apply those facts to novel situations.

The teaching method in the GTSP is designed to promote higher order, creative, critical thinking (Taber & Corrie, 2007; Tomlinson, 2005; Van Tassel-Baska, 2005; Van Tassel-Baska & Stambaugh, 2006). The students are exposed to extensive, open-ended, authentic tasks which allow them to problem solve in the context of real-life situations to attain a measure of scientific literacy (Abrams, 1998; Rayneri, Gerber, & Wiley, 2006; Taber & Riga, 2007; Yoon, 2009). An authentic task is usually multidimensional and simulates a real world problem, so prior knowledge is used in context. On occasion these tasks are assessed by a real audience (Hart, 1994; Melograno, 1996). Student motivation also stems from such tasks as they connect with students' personal and social contexts (Bybee, 1993; Park & Oliver, 2009). To improve student ownership of aspects of assessment, the criteria and standards of the marking rubrics for selected tasks are negotiated between the students and the teacher.

One aim of the GTSP is that the students become self-regulated learners, reflecting and using higher order thinking strategies autonomously, so they become independent, life-long learners. Consequently, certain tasks within the GTSP are designed to promote self-regulated learning, "Students should be assisted to reflect on their learning, thinking about how they learn and the conditions that help them learn" (Curriculum Council, 1998, p. 36).

Research Purpose

Gifted education should facilitate development of the skills, concepts and attitudes that allow gifted students to realise their potential and become life-long learners. In order to improve the educational outcomes for gifted and talented students there is a need to research the processes by which specific factors affect student motivation and subsequent behaviour to answer such questions as "How and why do different educational outcomes come about over time?" (S. Gallagher, 2006, p. 188). Accordingly, the purpose of this research was to determine the nature of the experiences of students in the gifted and talented science program at Metropolitan High School that assisted them to achieve their academic potential (Taber, 2007a).

At the time when the study was conducted in Western Australia the education system was in the midst of change. Decisions about what kind of learning society values had been made and schools were implementing an outcomes based educational model. From a sociocultural perspective, successful teaching involves both helping learners to accomplish learning goals and helping them to experience the value in doing so (Brophy, 1999).

Society wants genuine understanding and students who love to learn and value life-long learning, yet at the same time imposes conditions that make those goals unattainable (Russell, 1993; Taber, 2007a). Personal experience as a classroom teacher leads me to propose that in Western Australia it is the reporting process in schools that ultimately drives teaching and learning, and assessment practices ultimately provide a constraint to educational best practice.

Novak (1996) states that the belief system that prevails in many science departments in schools is a positivist approach to teaching, where learning involves memorising a mass of facts. Traditional methods of teaching and assessment are thought to repress educational innovation and hinder learning (Rennie, Goodrum, & Hackling, 2001; Wisker, 2001). Teaching for understanding takes time therefore some parts of the science syllabus may not be covered adequately (Vance & Miller, 1995). It is acknowledged that learning for understanding cannot take place without factual knowledge, however balance is essential (Goodrum, 2004).

At MHS summative, common assessment tasks in the form of pencil and paper tests are used for comparability; academic marks are awarded on the common assessment tasks. An algorithm is used to convert the mark to a grade for the final school report. Marks are used to rank students within their cohort. This ranking is then used by administrators to make decisions concerning the movement of students into and out of the GTSP. Research suggests that to promote an interest in learning for its own sake, normative assessment practices should be avoided, as constructivist approaches to assessment are thwarted by such traditional assessment practices (Jagacinski, 1992). It therefore appears that the common assessment tasks at MHS introduce an institutional constraint on the teaching methods in the GTSP.

When time permits, students in the GTSP complete complex, criterion referenced, authentic tasks, but resultant performance levels only contribute marginally to summative reports. This has resulted in perceived tension between the underlying philosophy of teaching within the GTSP and the institutional assessment practices given greatest status (Taber, 2007a). With this tension in mind, aspects of this research attempted to determine if the different types of assessment used in the MHS GTSP caused students to abandon deep learning in favour of surface approaches, which will ultimately affect realisation of their talents. In the context of the GTSP achievement measures are used to gauge the extent of demonstration of a student's gift in science.

Learning goals are an important intrapersonal catalyst in Gagné's model of giftedness contributing to the realisation of a student's talents (Gagné, 2006, 2010; Gross, 2005b). Goal performance has been shown to vary with situational differences as well as individual ones. Achievement goals may be separated into two main categories: learning goals and performance goals. "Put simply, with performance goals an individual aims to look smart, whereas with learning goals the individual aims at becoming smarter" (Dweck, 1985, p. 291).

This research investigated whether the MHS GTSP enhanced a deep approach to learning (Biggs, 1987b) and associated learning strategies. In particular the focus was to determine if certain types of assessment fostered a deep approach to learning and associated use of deep, self-regulated learning (SRL) strategy (Taber, 2007a; Zimmerman & Martinez-Pons, 1990), which will ultimately affect the realisation of the gifted students' talents. Use of SRL strategies, in particular higher order thinking strategies and the adaptive use of cognitive organisers, for organising and transformation of information for specific types of assessment task were investigated. The ability to transform information is vital to the attainment of high levels based on the developmental progress maps of the Curriculum Framework of Western Australia (Curriculum Council, 1998).

Learning environment research indicates that educational outcomes for students are improved when there is congruence between the students' preferred classroom environment and the actual classroom environment (Fraser, 1990). Moreover, the classroom environment is one aspect of the milieu that forms an environmental catalyst in Gagné's model (Gagné, 2006, 2010) that facilitates the transformation of gifts into talents. As a consequence it was appropriate that the research examined the congruence that existed between the GTSP students' preferred and actual classroom learning environment at MHS.

Teachers have a role of developing students' positive self-efficacy. This is achieved through the quality of relationships with students, by allowing student autonomy in the learning context and by providing the appropriate scaffolding during tasks that are cognitively challenging (Patrick, Gentry, & Owen, 2006; Turner & Meyer, 1999). Thus an examination of the students' perceptions of self-efficacy was part of this research.

The research questions were borne out of the research purpose to determine if the experiences of students within the GTSP assisted them to achieve their potential in science. It was the intention that this research would provide specific data which is currently lacking in the field of gifted and talented secondary science education.

Research Questions

1. What is the nature of the teaching and learning context within the Gifted and Talented Science Program at Metropolitan High School?

2. How and why do the experiences of students in the Gifted and Talented Science Program affect learning approach, self-regulated learning and self-efficacy of learning?

3. What evidence of achievement exists for students in the Gifted and Talented Science Program to suggest they are reaching their potential and demonstrating talent in the field of science?

4. Is there variation among students in the impact of their participation in the Gifted and Talented Science Program?

Personal Historical Context of the Researcher

I am currently a consultant for the Department of Education and Training in the area of classroom management strategies which embeds instructional strategies. I am also an experienced teacher of science at MHS. I achieved Level 3 classroom teacher status (L3CT) in 2004. L3CTs undergo a rigorous, criterion referenced selection process in order to be promoted to this level, in recognition of their exemplary teaching practices in line with the outcomes based philosophy of the Western Australian Curriculum Framework (Curriculum Council, 1998). I was appointed to MHS as a permanent teacher in 2000. Since the inception of the GTSP in 2003 I have taught gifted and talented students within the program. In both 2006 and 2007, when the study was conducted, I taught two GTSP classes.

The extent to which an outcomes based approach (Curriculum Council, 1998) has been implemented in the science departments in which I have worked varies. The introduction of mandatory reporting in levels (based on a criterion based system) in Western Australia in 2005 prompted greater use of assessment practices at MHS that would provide summative data on students' levels of achievement. However, mandatory reporting in levels by teachers did not signify their endorsement of an outcomes based teaching philosophy. To compound the situation, traditional teachers in positions of authority essentially can impede the use of teaching and assessment practices aligned to the outcomes based model, by continuing to promote programs and assessment that equate rigour with mastering copious amounts of factual content. A change to the reporting system in 2007, such that levels no longer had to appear on the students' final reports, had a backwash effect; the researcher's classroom experience suggests it supported the dominant positivist paradigm in many secondary school science departments. In this paradigm, information is transmitted to students, learning is equated with factual recall and assessment is used to determine which students have been successful in acquiring facts (J. Gallagher, 1993).

Constructivism represents a perspective that has a goal of helping students understand, but it can be seen as generating interference with the dominant paradigm (Russell, 1993). In constructive alignment (Biggs, 2003), teaching and assessment practices are synergistic. Assessment needs to support the process of integration where students build on their conceptual framework, apply their knowledge to real-life problems and develop higher order thinking skills (J. Gallagher, 1993).

Whilst a teacher in Western Australia in 1996 I attended a science teacher leaders' course to improve my understanding of outcomes based science education and assessment practices. Since that time I have taught at numerous secondary schools and I have taken every opportunity to hone my understanding of current best practice pedagogy. In 1996, I began to develop and implement formative, open-ended assessment tasks. The Western Australian Outcomes and Standards Framework (Education Department of Western Australia, 1998) was used to delineate levels achieved by students and provide a framework for discussion after the assessed tasks had been returned to the students. I became concerned, however, that these discussion sessions did not appear to provide appropriate feedback to assist the students to achieve higher levels on subsequent tasks. Moreover, as the tasks were not common to all classes, they did not contribute significantly to the students' summative reports.

As a consequence of my concerns about feedback, I began to provide assessment rubrics with the tasks, to inform the students about the assessment criteria and standards prior to them attempting the specific task. These rubrics used pointers from the Outcomes and Standards Framework to clarify the difference between levels, but did not extend assessment beyond science criteria.

Further professional development in 2003 assisted me to set more encompassing tasks that included criteria from the overarching outcomes of the Curriculum Framework in addition to science outcomes (Curriculum Council, 1998). These authentic tasks required students to problem solve in the context of real-life situations. The tasks allowed individuals to pursue areas of interest and produce products which matched their particular learning style, an aspect of providing a differentiated curriculum. Student negotiation of the assessment standards and criteria increased the sense of student ownership of such tasks. The science outcome level statements on the assessment rubrics were non-negotiable, but since the tasks were multi-dimensional there was plenty of scope for student input into other criteria of the assessment rubric.

To help the students become familiar with tools that facilitate higher order thinking, another dimension to the authentic tasks was that they frequently included strategies to facilitate the transformation of information. Specific strategies to assist with the planning and final production of the task were also embedded. The assessment rubrics were also designed to incorporate the effective use of relevant strategies as one of the criteria. In relation to self-regulated learning: students had to plan and monitor their use of time, self and peer assessment were used to facilitate reflection on the effectiveness of learning strategies and journal entries assisted metacognition.

Such authentic assessment tasks were time consuming. For example, student negotiation of a rubric took at least one hour of class time. Within the GTSP curriculum compaction freed some time for authentic tasks. However, as discussed earlier, these tasks only contributed to the students' summative reports to a marginal degree. In a content laden curriculum students were disadvantaged with respect to traditional assessments, the common assessment tasks in the MHS context, as they have had less time to learn the facts on which the assessments were based. The common tasks were the ones that featured heavily on the summative reports. The conundrum was that even though the authentic tasks were designed to inculcate a deeper approach to learning and self-regulation, my perception was that some students perceived they had less value than the common assessment tasks and therefore resented the time and effort taken to complete them.

The role of educators is to promote enjoyable, effective achievement and equip students with the motivational patterns to maximise their potential. One role of educational researchers is therefore to discover how this can be accomplished by teasing out the antecedents that underlie academic success (Dweck, 1985; Jinks & Morgan, 1999). Thus, the dilemma over assessment practices has led to this research to determine if the MHS GTSP enhances deep learning goals and associated learning strategies. Student satisfaction with the learning environment was evaluated by investigating the congruence between the students' preferred and actual classroom learning environment.

Dealing with Subjectivity

The Researcher's educational background, discipline, philosophy, experience and skills (Kumar, 1999) were the source of limitations to the conceptualisation of this study. The statement of the Researcher's position which follows in the next section may help elucidate such limitations to the conceptual framework that exist so they are not perceived as bias. ". . . we live forever in our own, self-constructed worlds; the world can never be described apart from our frames of experience" (Roth, 1999, p. 7).

The data collected during participant observation, focus group interviews and one-on-one interviews of students were neither completely emic; data arising in natural form, nor etic; data representing the Researcher's imposed view on the situation (Stewart & Shamdasani, 1990). The data collected from the interviews was more towards the etic side of the continuum, affected by the nature of the respondents and by decisions made by the Researcher on analysis of the data. Data from the participant classroom observations was more towards the emic side of the continuum (Stewart & Shamdasani, 1990). In examining the framework for this research and conclusions drawn, one must take into consideration my personal bias. Consequently the following section is an open declaration of my personal bias in relation to this research.

As a teacher at MHS I support the concept of special provision for gifted and talented students. My personal classroom experience leads me to suggest that frequently extra time and resources are channeled into meeting the needs of students with learning difficulties or behavioral problems, whilst gifted and talented students are left to their own devices. The gifted and talented can often perform at seemingly high levels without intervention, but this does not mean they are achieving to their potential. These students may possibly be losing interest in school as tasks lack the appropriate level of cognitive challenge for them (Gagné, 2010).

Literature also highlights the problem of the hidden gifted, students in heterogeneous classes who have responded to a forced choice dilemma by hiding their gifts so they can fit in socially with their peers (Gross, 2005b; Park & Oliver, 2009). In the GTSP classes where gifted and talented science students were taught together there was a reduced need to make such a choice. It is noted that students who have not engaged with learning for a period of time may have reduced metacognitive skills and also may have impaired cognitive efficiency, either way, they will not be able to achieve to their potential. Theories of self-regulated learning provide evidence that self-regulatory strategies and metacognition can be taught and the acquisition of such skills leads to increased feelings of self-efficacy (Chaffey, 2005).

The application of successful innovations tested in the context of gifted education to education in general is supported by a wide range of research (Renzulli, 2005; Tomlinson, 2005). Thus it is hoped that the recommendations of this research based on a gifted and talented science program can be extended to science programs in general. The next section focuses on the development of the conceptual framework that framed the research questions and guided the research methodology and data analysis.

Significance of the Research

In providing a special program for the gifted at MHS it was incumbent on teachers of the program to ensure that the program was meeting the students' needs. The significance of this research was that it provided an in-depth analysis of the implemented GTSP and examined the extent to which the program made a difference to student learning. Currently this type of analysis is lacking in the field of gifted education (Van Tassel-Baska, Quek, & Feng, 2007). This study conceptualises how learning experiences provide the catalysts described in Gagné's model (Gagné, 2006, 2010) to translate students' gifts into talents. In particular intrapersonal characteristics were investigated such as learning approach, self-regulation and self-efficacy of learning in an attempt to determine if the GTSP assisted in the development of autonomous life-long learners. The relationships between environmental factors as existed within the GTPS at MHS and intrapersonal factors were examined to determine the nature of mediating factors in the development of desired intrapersonal traits. It is hoped that the findings of this study have the potential to inform future educational practices within the GTSP at MHS and also science teaching in general, both within MHS and beyond.

CHAPTER 2

LITERATURE REVIEW AND DEVELOPMENT OF THE CONCEPTUAL FRAMEWORK

In this section, the literature related to the constructs underpinning this evaluation of a gifted and talented science program is reviewed and developed into a conceptual framework. Following an introduction to gifted and talented education in general, the review discusses the related literature in relation to the intrapersonal and environmental catalysts that affect the translation of a student's gift into talent in accordance with Gagné's model of giftedness and talents (Gagné, 2006, 2010). Intrapersonal catalysts discussed include learning approach, self-regulation of learning and self-efficacy of learning. Environmental catalysts which are the subject of review include milieu, classroom environment, constructivism and evidence of achievement.

Gifted and Talented Education

In 1989, Miraca Gross began an Australian longitudinal study of exceptionally gifted children. Professor Gross used the findings of previous overseas studies to generate research questions and guide her towards issues that might be explored to develop theory. Her methodology involved a series of comparative case studies of the academic, social and emotional development of 15 children scoring at IQ 160+ in the Eastern States of Australia. An important goal for her research was that the results could be used to advise schools about appropriate programs for gifted children. This point was reached in 1993 (Gross, 1993).

Professor Gross (University of New South Wales) was a major contributor to a professional development package for teachers in gifted and talented education produced by the Gifted Education Research, Resource and Information Centre (GERRIC) which was funded by the Australian Government (Gross, 2005a, 2005b). This package was utilised by the Western Australian Department of Education and

Training, to improve the provision of appropriate programs for the gifted in Western Australian Schools including MHS. The package used the definitions and constructs of Françoys Gagné's differentiated model of gifts and talents (Gagné, 2006).

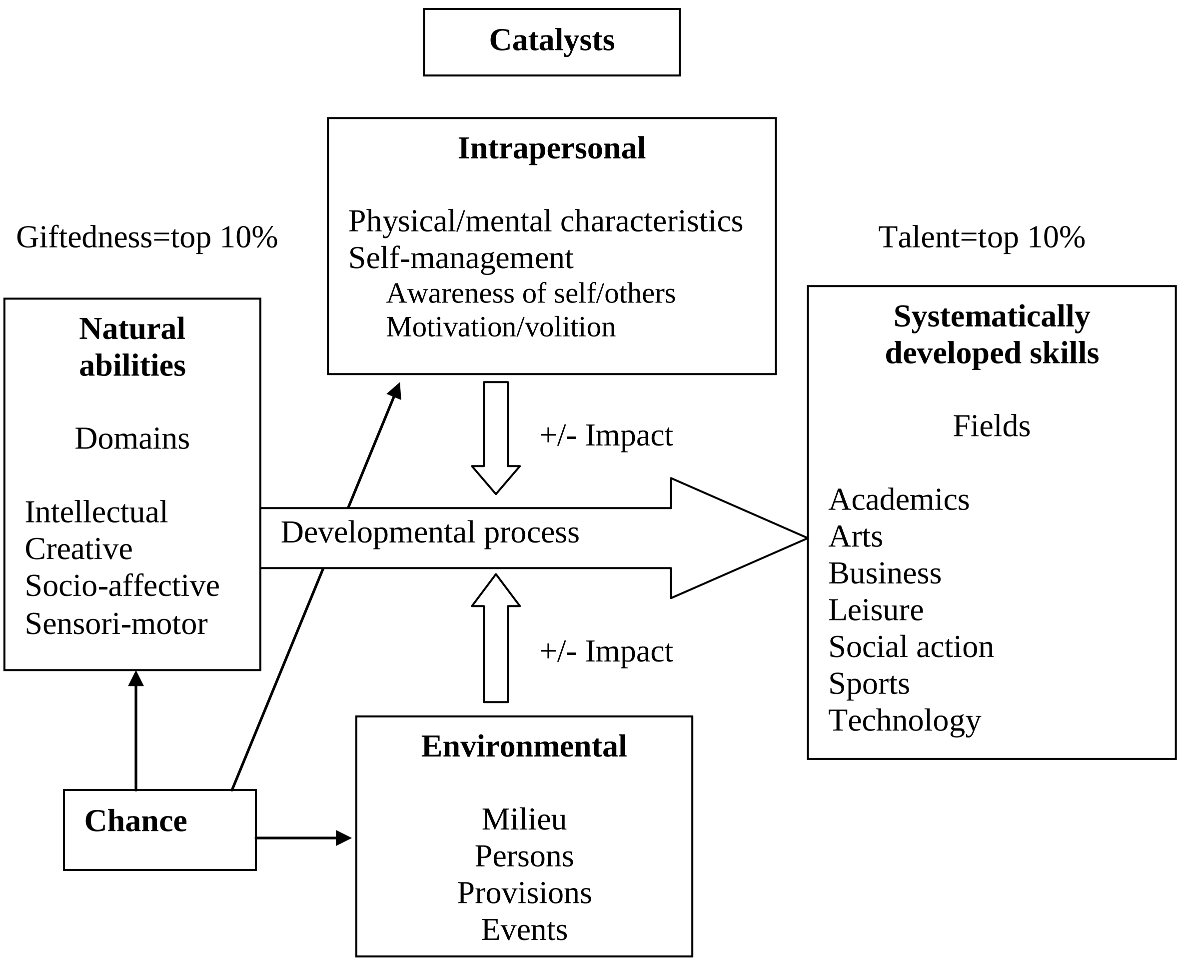

Figure 2.1. Gagné's model of giftedness and talents (Gagné, 2006; Gross, 2005b).

The differentiated model of gifts and talents of Françoys Gagné (Figure 2.1) was developed in 1985 (Gagné, 2006). It presents giftedness as exceptional competence in an area and talent as exceptional performance. A gifted student possesses potential significantly above their chronological age in any of the domains of human ability; intellectual, creative, socio-affective and sensori-motor. A gifted student becomes talented when they display superior performance in a particular field. The model shows how intrapersonal and environmental variables link potential and performance.

Catalysts that affect the translation of gifts into talents include intrapersonal factors such as adaptive strategies, and environmental factors such as provision of appropriate educational programs and milieu. Thus, quality of learning is central to Gagné's model of giftedness and talent (Gagné, 2006; Gross, 2005a, 2005b). Teachers of the GTSP at MHS are conversant with Gagné's model and strive to foster the intrapersonal catalysts and provide the environmental catalysts that will transform students' gifts into talents (Figure 2.2). As a consequence, Gagné's notion of moving gifted students, with natural abilities, through a developmental process to become students with systematically developed skills, or talents, provided the initial schema from which the conceptual framework for this study was developed in a process outlined in each of the sections of the literature review.

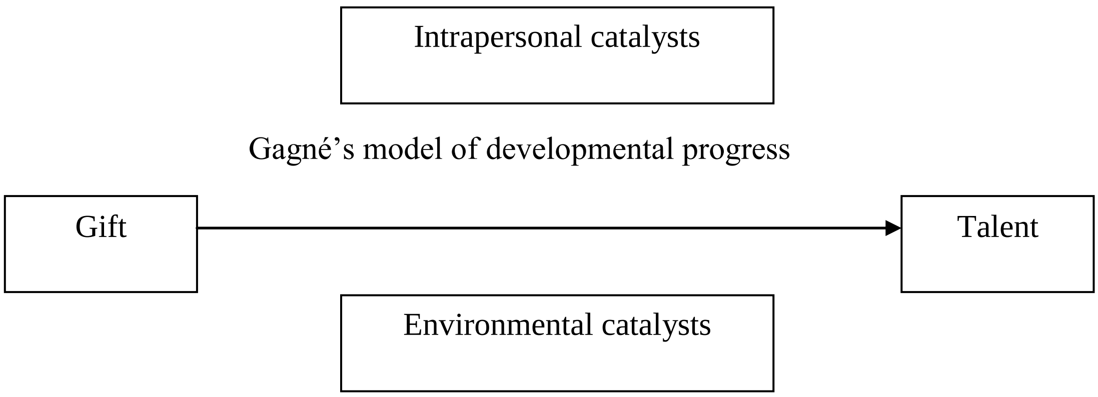

Figure 2.2. The translation of gifts into talents.

The system approach to learning is encapsulated in Biggs's presage-process-product (3P) model of learning (Biggs & Moore, 1993) (Figure 2.3). The model draws from an individual constructivist perspective where knowledge is constructed internally and tested against the outside world (Prosser & Trigwell, 1999). In this model learning forms a system, each part being independently constituted, but integrating continuously with other parts. In education, systems operate at several levels: task, classroom, school and state education system.

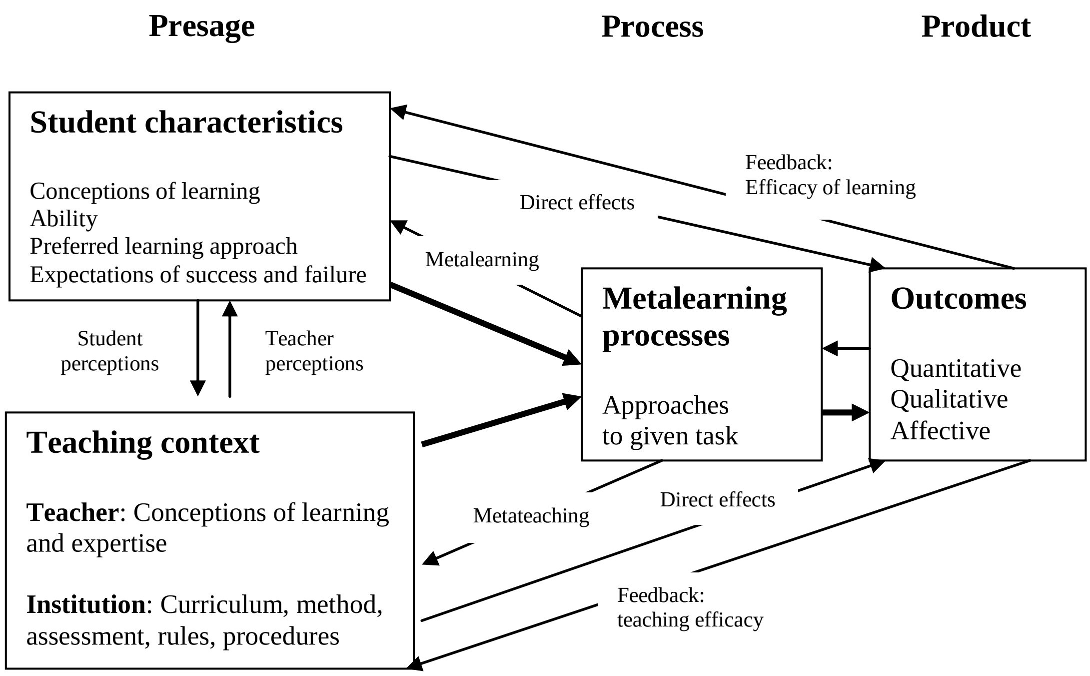

Figure 2.3. The 3P model as a classroom system (Biggs & Moore, 1993, p. 451).

Note. Dark arrows indicate main directional force, lighter arrows the interactions between components in the system.

In the 3P model, learning related factors affect the system at three points in time (Biggs, 2003). Presage factors are in operation before the learning task. They are of two kinds, student based and teaching context based. Student based presage factors include prior knowledge, motivation and ability. Factors that are teaching context based include what is intended to be taught, how it will be taught and assessed, teacher expertise, classroom climate/ethos and institutional climate/ethos. Process factors operate during classroom interaction. The presage factor conceptualised as student approach to learning interacts at this point to determine students' learning related activities (Biggs, 2003). When items in questionnaires mention student approach to learning it is usually in the context of a predisposition, in other words located in the presage level of the 3P model (Richardson, 2000). Approach to learning is discussed in detail in a further section of this literature review. Product is usually quantified as student achievement, the outcome of learning quantitative facts and skills, the effective use of learning strategies and affective involvement. The variations within and between learning contexts at the presage and process stages are of immense importance to the quality of learning outcomes (Meyer, 1998).

Rayneri, Gerber and Wiley (2006) commented that more research was required in the area of learning style preferences, perceptions of classroom environment and their relationship with the achievement of gifted students. In order to examine the factors that facilitated demonstrable student achievement of academic potential, this research investigated: student presage factors such as learning approach, self-regulation of learning and self-efficacy of learning; contextual factors such as classroom environment and assessment practices; and process factors such as learning approaches and the use of self-regulatory strategies in relation to specific tasks.

Intrapersonal Catalysts

Ames (1992a) states that little research has focused on changing the predominant goal orientation in a classroom brought about by the teaching and learning context. Furthermore, Turner and Meyer (1999) indicate that although classroom practice is often not reflective of current motivational theory, it is also true that only limited research theory is based on actual studies in classroom settings. Literature on motivation currently emphasises a cognitive and human information processing framework, rather than a behavioural framework of motivation. Cognitive views of motivation are concerned with the internal or cognitive mediational processes influencing behaviour and focus on why students choose to engage in academic tasks. Such views try to explain the higher order learning that occurs in complex, ill-structured classrooms. Change in students' motivation is thought to result from changes in their beliefs or self-perceptions (Rueda & Dembo, 1995).

This research endeavours to link motivation theory with classroom practice by incorporating aspects of motivation theory, namely learning approach, self-regulated learning and self-efficacy into the conceptual framework (see Figure 2.4). Each of these aspects will be discussed in sections to follow.

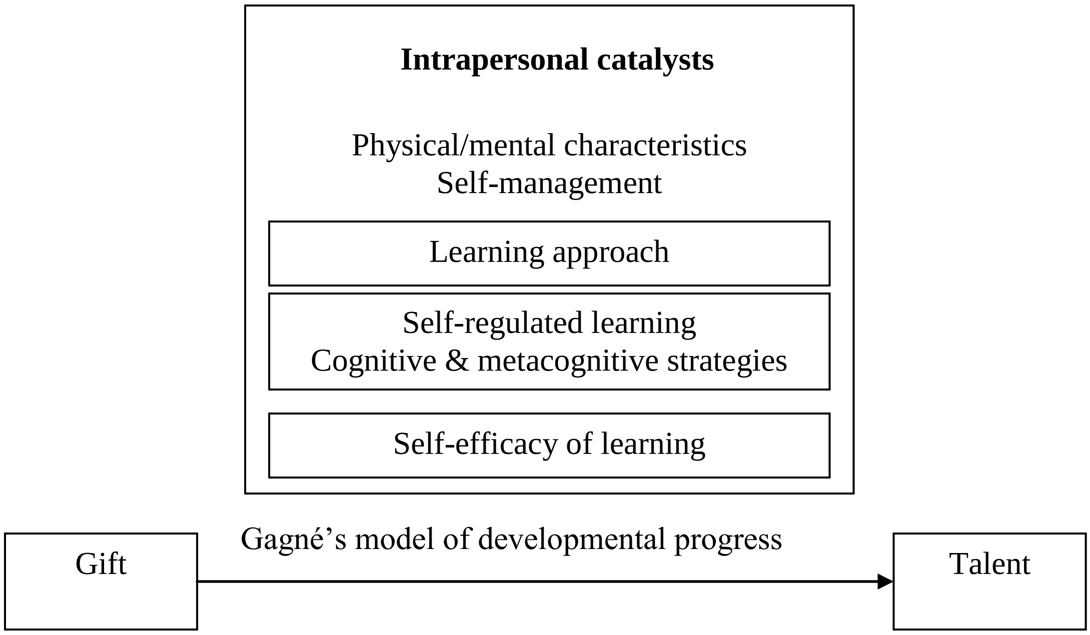

Figure 2.4. Intrapersonal catalysts.

Learning Approach

According to goal theory, goals are reasons for trying to succeed at a learning task (Ames, 1992b; Maehr & McInerney, 2004; Patrick, Gentry, & Owen, 2006). Some goals postulated are: ability oriented (performance) motivation, task oriented (mastery) motivation and socially oriented motivation to gain social approval. These motives are all attraction as opposed to avoidance motives (Gagné, 2010). Many gifted students choose to underachieve in order to gain social acceptance, bowing to the forced choice dilemma (Gross, 2005a), however, consideration of this goal was beyond the scope of this research.

> A self-conscious and planful approach to learning . . . requires, first, that students are aware of their motives and intentions, of their own cognitive resources, and of the demands of academic tasks; and second, that they are able to control those resources and monitor their consequent performance. (Biggs, 1988, p. 187)

A learning approach describes a qualitative aspect of learning (Ramsden, 2003). It is an interaction between environmental and intrapersonal factors. Biggs (1987a) describes a learning approach as a composite of a motive (goal theory motivation) and an appropriate strategy. Pask (1988) uses the term learning strategy to describe the ways in which a student tackled a problem solving task, as distinct from learning style which is used to describe a student's preferred learning strategies.

The approach to learning concept was first introduced in 1975 by Marton in relation to student reading of academic articles (Bain & Zimmerman, 2009; Biggs & Moore, 1993). The concept was used about a student's immediate engagement with the task at hand (Ramsden, 2003). Surface learning was described as sequential or atomistic when the student did not reorganise or reinterpret the text, but was simply concerned with verbatim recall of text or the ideas presented in it. With a deep approach a student read with the intension of extracting personal meaning, adopting a holistic approach that resulted in the making of connections between new knowledge and prior schema (Entwistle, 1988).

Whilst acknowledging the surface/deep dichotomy in approaches to learning, and consensus amongst researchers about their characteristics (Ames & Archer, 1988; Dweck, 1985; Entwistle, 1988; Marton, 1988), Biggs (1987a) postulated a third "achieving" approach to learning. Surface and deep approaches describe ways in which students engage with the content of tasks. However, the achieving approach is not concerned with how the task content is engaged, but focuses on maximising effort (Prosser & Trigwell, 1999), self-organisation and the management of time and resources (Richardson, 2000). Few data are available on the links between learning approach and resource management (Vrugt & Oort, 2008). Whilst some research concludes that there is little evidence to support the achieving approach, it is recognised that a dimension beyond the surface, deep approach dichotomy is required to ensure that students apply themselves to complete a task (Kember & Leung, 1998). The achieving approach is therefore aligned to certain of the dimensions of self-regulated learning as described by Zimmerman (1988) which will be discussed in the next section of this chapter. More recent research suggests that certain students vary their learning approach in order to cope with the assessment demands of their courses (Gijbels, Sergers, & Struyf, 2008). The possible conflict between learning goals and the assessment practices used at MHS to show evidence of achievement within the GTSP is shown in Figure 2.5. Kember and Leung (1998). recognise that the achieving dimension can present simultaneously with the surface and deep orientations. Furthermore Biggs (1988) states that the composite of deep/achieving approaches is a characteristic of many high achievers.

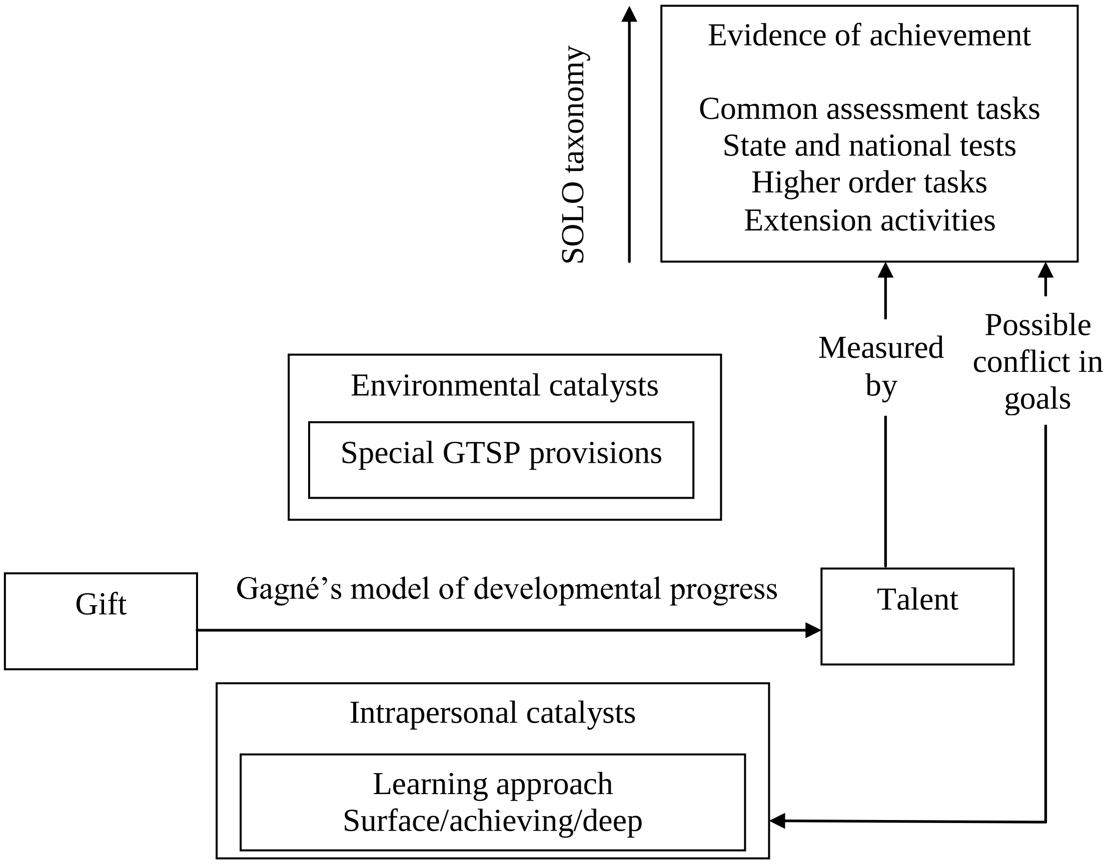

Figure 2.5. The relationship between learning approach and assessment.

Marton (1988) notes a clear relationship between a students' approach to learning and learning outcomes as described in the SOLO taxonomy (Collis & Biggs, 1979). Marton postulates that students with a deep approach to learning are able to show evidence of relational and extended abstract learning outcomes that surface learners are not capable of. Moreover, surface learners are capable of multi-structural outcomes at best. Thus it appears that a student's learning approach is an intrapersonal variable that has direct bearing on the translation of gifts to talents (Figure 2.4). Adoption of neither a surface nor deep approach when faced with a task is called non-engagement (Prosser & Trigwell, 1999). Good teaching involves facilitating a deep approach to learning, whilst trying to remove those contextual factors which promote surface learning. Additionally promotion of an achieving approach in tandem with deep is likely to be the most adaptive.

Based on the 3P system model (Figure 2.3), Biggs (2002) stresses the concept of constructive alignment which necessitates consistency between a constructivist understanding of the nature of learning and teaching practices. In such alignment critical components of a teaching are integrated, by the teacher, towards the common end of deep learning. The critical components include: curriculum, teaching methods, assessment and reporting procedures, the climate teachers create in their interactions with students and institutional climate, rules and procedures. Biggs, (2002) comments that academic students can spontaneously use higher order thinking processes even within a poor system evidenced by misalignment. He goes on to suggest that during a lecture, or reading of a set text, within the process phase of his 3P model, top students will be able to activate a form of learning other than reception of selected content is the default. Thus, Biggs suggests that imbalance at any point in the system leads to poor teaching and surface learning in all but the best students, presumably those gifted in the related academic field. Biggs considers a surface approach as a learning pathology that does not engage a task in the way it should be engaged (Biggs & Moore, 1993).

Prosser and Trigwell (1999) indicate that literature includes three perspectives of learning approach: approach to an ongoing learning task, approach adopted in a prior learning task that was similar and prior orientation to learning. It is the later perspective that is adopted in this research study with an approach viewed as a predilection to address a range of tasks in a particular way. Research also suggests that approach to learning is not stable, variability in approaches coexists with consistency, as students perceptions depend on their learning situations (Biggs, 2003; Gijbels, Sergers, & Struyf, 2008; Prosser & Trigwell, 1999; Ramsden, 2003; Schmeck, 1988). Such adaptation by students of their learning approach to their perception of what is required is called 'study orchestration' ". . . students react by tuning their approach to learning to suit the environment to which they were exposed" (Biggs, 2003, p. 25). The conflict between learning approach and assessment practices is shown in Figure 2.5. Recent research suggests that further work needs to be done to explore the coexistence of two distinct groups with respect to learning approach: one with a restricted learning approach and one with variability in learning approach (Gijbels, Sergers, & Struyf, 2008).

The "three approaches to learning model" (Biggs, 1988), was used as a measure of a student's predilection to a learning approach to inform this research because each approach is clearly defined and differentiated. Even after reviewing literature noting the controversy over the achieving approach, it was decided that survey of the achieving approach dimension would allow the Researcher to access data aligned to self-regulated learning. The Learning Process Questionnaire (LPQ) was designed by Biggs to measure the learning approach of students of school age (Biggs, 1987b) and was therefore selected as a data collection instrument in this research. The quality of the teaching environment can be inferred by changes measured by the LPQ as students adapt to the expectations within their classroom context (Biggs, 2003). Learning approach is an important focus in relation to Research Questions 2 and 4. A more detailed description of the LPQ follows in the research methodology chapter.

Biggs (1988) explains that a student exhibiting a:

- deep approach searches for meaning beyond the task at hand, relates information to their prior conceptual framework and personalises learning tasks;
- achieving approach focuses on marks aiming to pass, only learns what they perceive as necessary, does not link information to prior understanding and retains little; and
- surface approach sees knowledge as acquisition of facts, relies on rote learning and does not link information to prior understanding.

It should be noted that more current research differentiates between rote learning and deep memorising (Kember, Wong, & Leung, 1999). A person learns by rote when they have no intention of understanding the meaning of material. Deep memorising and rehearsal, by engaging in practice questions, has the intention of gaining relational understanding of theory and concepts therefore the learning intention differs from rote learning. Many science students adopt deep memorising strategies (Prosser & Trigwell, 1999).

Outcomes Based Education and Approach to Learning

In a national survey of Australian schools Biggs found that between Years 8 and 11 students' surface approach to learning declined, but so did use of a deep/achieving approach and more so in boys than girls. However such effects can be overcome by creating a good affective and cognitive learning climate (Biggs & Moore, 1993).

A student's approach to learning is an intrapersonal catalyst that plays a key role in their likely success in the outcomes based curriculum model that has been adopted in Western Australia and within the GTSP at MHS. Traditional didactic methods of science teaching lead to a surface approach where students see knowledge as acquisition of facts, rely on rote learning and do not connect new knowledge with prior understanding (Biggs, 1987a). Surface learners are more likely to value extrinsic rewards (Maehr & McInerney, 2004). Students and teachers emphasising recall exacerbate the difficulties experienced when knowledge needs to be applied to everyday situations (Boekaerts, 1996).

Students with an achieving approach use whatever strategies they feel they need to succeed, even cheating (Maehr & McInerney, 2004), it has a negative impact on collaborative learning (Biggs, 2003). Traditional teaching methods make it possible for a student with an achieving approach to earn high grades by memorising what they perceive as necessary to pass assessment tasks. As such the achieving approach may be considered the key to success (Wilding & Andrews, 2006). Students with an achieving approach see the teacher as an evaluator because judgments about their competence are made on the basis of performance relative to others (Ames, 1992b). Such students perceive intellectual ability as a stable trait, thus failure is construed as lack of ability and will often result in loss of self-esteem (Cowan, 2002). The achieving approach, like the surface approach, is focused on the product, the achievement of high grades (Biggs & Moore, 1993). Students with this approach concentrate on study skills and the cost effectiveness of the use of time and effort. It involves a high degree of metacognition relating to context and content (Biggs & Moore, 1993). The effective use of time and effort, however, are recognised as characteristics of a self-regulating learner which is discussed in a following section within this chapter.

In contexts where students are called on to apply their knowledge, the complex tasks that promote higher order thinking and problem solving are likely to be shunned by those with an achieving approach, for such students evidence of competence on task completion is more powerful than their desire to learn (Brophy & Alleman, 1992; Patrick, Gentry, & Owen, 2006; Stipek, 1993). Teachers need to be aware of the possible conflicts between their classroom practices and their students' goal orientations otherwise they may capitulate to student pressure to minimise the cognitive demands built into their classroom activities (Brophy & Alleman, 1992; Richardson, 2000; Stipek, 1993).

Contemporary cognitive science research encourages the replacement of traditional didactic instruction and coverage driven teaching goals, with fewer topics studied in depth, so students construct conceptual relationships to facilitate scientific literacy (Treagust & Chittleborough, 2001; Wandersee, 2001). This approach is also reflected in the Western Australian Curriculum Framework:

> Students should be encouraged to see learning as an active process on their part, involving a conscious intention to make sense of new ideas or experiences and improve their own knowledge and capabilities, rather than simply to reproduce or remember. (Curriculum Council, 1998, p. 34)

In an outcome based educational system it is important for students to truly understand the concepts being presented and apply them to problem solving scenarios, in other words, to exhibit a deep approach to learning. A deep motive is based on interest (Biggs & Moore, 1993). Students with a deep approach seek challenging tasks that allow them to develop their understanding and see their teacher as a resource or facilitator in the learning process (Meece, Blumenfeld, & Hoyle, 1988; Stipek, 1993). They are more likely to use deep strategies like monitoring, going over things they do not understand and relating current work to their prior conceptual framework. They are also more likely to persevere in school as they relate failure to lack of effort or inappropriate personal strategies (Ames, 1992b; Shi, Wang, Wang, Zuo, & Liu, 2001). Students with a deep approach view intellectual ability as a dynamic trait that can be developed by greater effort and academic challenge (Cowan, 2002). Deep approaches produce better results and longer-lasting learning. Paris and Byrnes (1989) conclude that students exhibiting such approaches consistently score higher on measures of academic achievement. Optimism in relation to the results of learning situations and persistence during learning are supported in students who set themselves learning goals, who recognise the intrinsic value of learning and who perceive they have high academic ability (Tomlinson, 2005). It has been suggested that the selection of students for top universities should incorporate measures of deep learning (Mellanby, Cortina-Borja, & Stein, 2009). Optimism in regards to learning is aligned to positive self-efficacy of learning which will be discussed in a further section of this chapter.

Deep and achieving approaches are orthogonal (independent dimensions, not related to one another) so individuals may exhibit characteristics of both approaches. Research in various contexts and statistical analysis of data supports this view (Duarte, 2007). The composite of deep/achieving is a characteristic of many high achievers (Biggs, 1988; Cassidy, 2006; Midgley, Kaplan, & Middleton, 2001; Pintrich & Garcia, 1991). The aims of deep and achieving motivation ultimately diverge as deep learning is associated with how to handle the task most appropriately and achievement motivation concentrates on engaging with a task with a view to attaining a high grade (Biggs, 2003). Students who adopt both surface and deep learning, or neither, are evidently high risk groups who display significantly lower educational outcomes (Prosser & Trigwell, 1999). The relationship between achievement and approach is the focus of Research Question 4.

The Curriculum Framework of Western Australia notes " assessment practices should be designed so that they do not inhibit risk taking or encourage short term and unproductive learning strategies: rather, they should encourage in-depth long-term learning" (Curriculum Council, 1998, p. 38). Assessment of students in Western Australia involves judgments about students' progress towards outcomes. Outcomes based education makes it possible for all children to achieve with reasonable effort; it replaced a norn-referencing system where only half of the children could perform above average. However, in 2007, the Department of Education and Training moved away from reporting to parents in levels. This is constructive misalignment at the level of the education system (Biggs, 2002, 2003). As a result schools could choose to use normative assessment to determine student grades. There are high expectations of GTSP students from parents, teachers, the school administration and government officials. Marton (1988) noted the importance of providing instruction that guides students to meet expectations. Evaluation of the success of the GTSP is based primarily on evidence of student achievement in common assessment tasks (see Figure 2.5). The achievement of students within the GTSP is the focus of Research Questions 3 and 4.

Self-Regulated Learning

Prior to discussing self-regulated learning it is appropriate to make reference to the use of this term within contemporary research and delineate between the terms self-regulation, self-regulated learning and metacognition. Dinsmore, Alexander and Loughlin (2008) undertook a meta-analysis of 255 pieces of contemporary research to explore the meaning of the terms, in the understanding that clarity of thought follows clarity of expression. After examination of the convergence and divergence of the constructs as discussed (Dinsmore, Alexander, & Loughlin, 2008), the following understandings have been incorporated in this research. Self-regulation involves control brought about by human thought and action in response to stimulation from the environment. When the environment is a classroom or an academic context, then the self-regulatory response is self-regulated learning. Metacognition is defined as thinking about thinking which results in the development of a self-regulated learner (Dinsmore, Alexander, & Loughlin, 2008).

Self-regulated learning (SRL) can be distinguished from learning that is externally regulated (Boekaerts & Cascallar, 2006). SRL theory has its origins in Bandura's triadic theory of social cognition (Bandura, 1997). Bandura's theory revolved around reciprocal determinism which states that each of the factors involved in SRL: environmental, personal and behavioural, affects the others (Figure 2.6) (Schraw, Crippen, & Hartley, 2006).

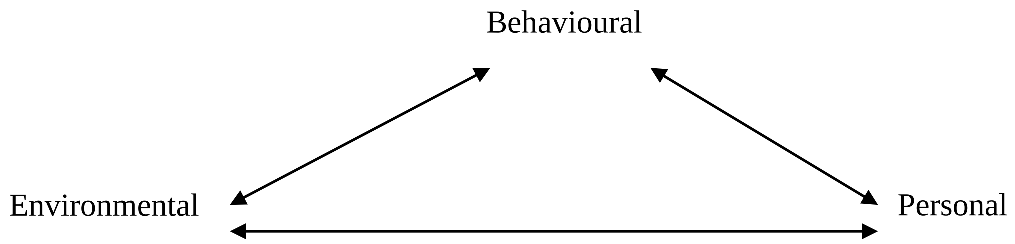

Figure 2.6. Reciprocal interactions in socio-cognitive theory (Schunk, 1989, p. 84).

One of Piaget's contributions to education, although his area of interest lay with cognition (Dinsmore, Alexander, & Loughlin, 2008), was to indicate that the context of learning should emphasise self-regulation (Biggs & Moore, 1993). SRL is relevant to many aspects of learning and control, which explains the diverse theoretical perspectives presented in the literature (Boekaerts, 1996; Dinsmore, Alexander, & Loughlin, 2008; Paris & Paris, 2001). Schunk (2008) notes that within these multiple theoretical frameworks it is important for researchers to decide their affiliation. Theorists holding views between those of operant theorists and phenomenologists favour motives driven by achievement success, goal accomplishment, self-efficacy and concept assimilation (Zimmerman, 1989a, 1989b; Zimmerman & Martinez-Pons, 1992). Within an intermediate theoretical perspective SRL involves the awareness and use of learning strategies, self-efficacy of learning and a commitment to academic goals. This view of SRL underpins the development of the conceptual framework for this research.

One of the components of SRL is motivation, the attitudes and beliefs of a learner in the development and use of their learning skills (Schraw, Crippen, & Hartley, 2006). The SRL model of Pintrich (1990) encompasses three motivational components to self-regulated behaviour: a value component, an expectancy component and an affective component. The value component involves students' goals for the task and their beliefs about the importance and interest of the task. In this research this component is conceptualised as a student's learning approach: deep, achieving or surface (Figure 2.5). A learning approach is a composite of a motive and an appropriate strategy. Students with a deep learning approach, who believe that the task is interesting and important will engage in more metacognitive activity, more cognitive strategy use and more effective effort management (Pintrich & De Groot, 1990). The extent to which the GTSP supports a deep approach to learning and associated SRL strategies is the focus of Research Questions 2 and 4.

The expectancy component involves students' beliefs that they are able to perform a task and that they are responsible for their own performance. Gifted students do not automatically exhibit self-regulation skills or confidence about learning new skills (Patrick, Gentry, & Owen, 2006). In this research the expectancy component is conceptualised as self-efficacy of learning. Self-efficacy can be seen to be linked to both SRL and evidence of achievement (Figure 2.7), although research shows that attributions and control beliefs also influence the use of learning strategies (Rueda & Dembo, 1995). A self-regulatory cycle enhances students' learning and their perceptions of self-efficacy (Zimmerman, Bonner, & Kovach, 1996). Students use self-regulatory processes to develop and use study skills and become more aware of their improvements in academic achievement enhancing self-efficacy (Sekowski, Siekanska, & Klinkosz, 2009). The self-efficacy construct is discussed in a further section of this chapter. Self-efficacy of learning is a focus of Research Question 2.

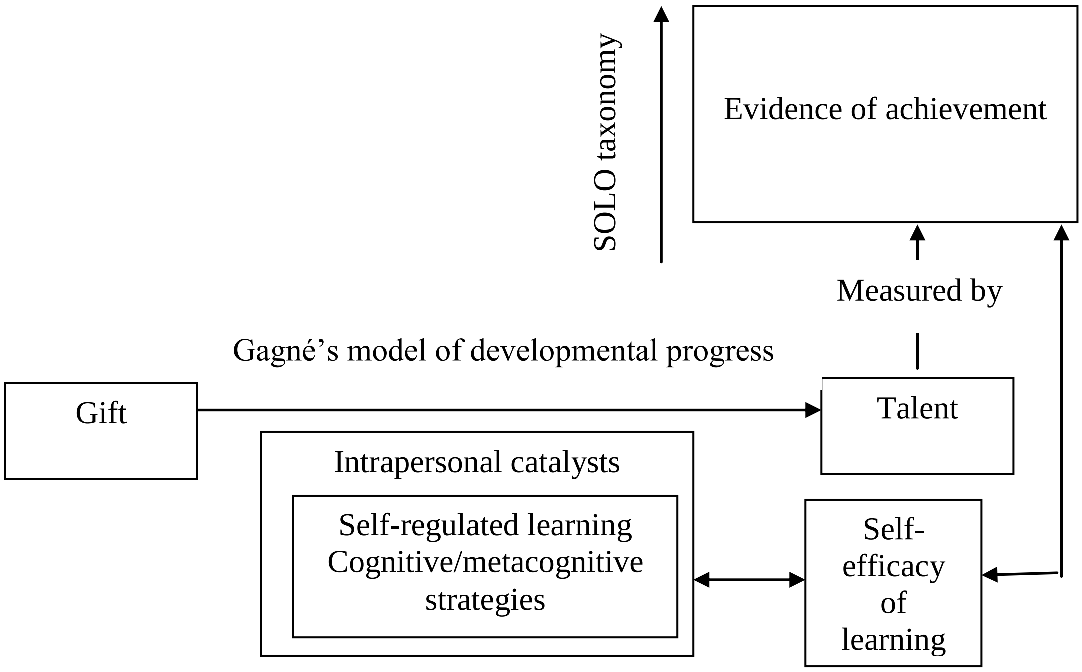

Figure 2.7. Self-regulated learning and self-efficacy as intrapersonal catalysts.

The affective component of SRL relates to students' emotional reactions to a task. One important affective response in the classroom is assessment anxiety, which is related to feelings of competence. According to Covington's self-worth theory of achievement motivation, an individual learns that society equates value to accomplishments, which explains how a person attempts to maintain positive ability perceptions that are the basis of self-worth (Rueda & Dembo, 1995). Academic self-concept involves internal comparisons, when students compare their performance in a subject with their performance in other areas, and external comparisons when they compare their performance with that of their classmates (McCoach & Siegle, 2003). Students' perceptions of their academic ability generally decline as they proceed through school (Nicholls, 1984). The competitive nature of many classrooms, exemplified by practices such as ranking of students at MHS based on the results of common assessment tasks (CATs), magnifies the positive affect associated with success (Sekowski, Siekanska, & Klinkosz, 2009) and negative affect associated with failure. The effect of evidence of achievement on self-efficacy is shown in Figure 2.7.

Moreover, as children get older they begin to make greater distinctions between effort and ability. They associate success with a great deal of effort as an indicator of lower ability, failure following significant effort elicits shame (Rueda & Dembo, 1995). The links between achievement and perceptions of self-efficacy are a focus of Research Question 4.

Self-regulation of learning occurs in three cyclical phases (Figure 2.8): forethought, performance and self-reflection (Zimmerman, 2004; Zimmerman, Bonner, & Kovach, 1996). The forethought phase involves the student in mapping out the task. The student analyses the task, sets goals and plans a relevant strategy (S.M Reis, 2004; Zimmerman, Bonner, & Kovach, 1996). It involves the presage factors described in Biggs' 3P model (Biggs, 2003) (Figure 2.3). The way a student engages at this point in the cycle is based on: student factors, like their learning motive and their perception about the purpose of achievement, behavioural factors, and context based factors, such as the classroom climate within the MHS GTSP which provide the student with information about the purpose of achievement (Urdan, Kneisel, & Mason, 1999).

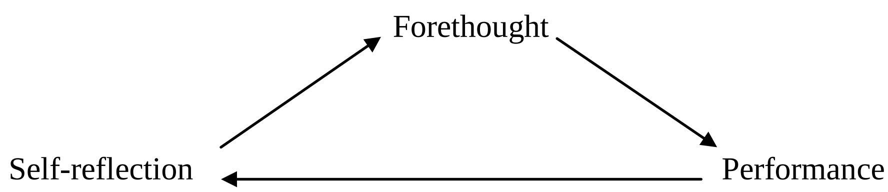

Figure 2.8. Cyclic phases of academic self-regulation (Zimmerman, 2004, p. 142).

During the performance phase (Zimmerman, 2004), the process factors of Biggs' model operate in tandem with presage factors (Biggs, 2003). Students use self-control processes, including the execution of cognitive learning strategies, during structured classroom interaction to improve outcomes. A learning strategy is a systematic plan that assists a student to encode information and complete a task (Paris & Byrnes, 1989; Zimmerman & Martinez-Pons, 1992). Fourteen categories of self-regulated learning strategies have been proposed, some cognitive, used to make cognitive progress, others metacognitive, used to monitor progress (Zimmerman & Martinez-Pons, 1988). They are also used to monitor the effectiveness of implemented strategies in respect to learning outcomes, this is called strategic outcome monitoring (Zimmerman, Bonner, & Kovach, 1996).

Students use different cognitive strategies for different tasks. Examples of cognitive strategies are: rehearsal (reading aloud, highlighting text), elaboration (paraphrasing, summarising, creating analogies, generative note-taking, explaining ideas to someone else, question asking and answering) and organisational strategies (selecting the main idea, outline of material to be learned, concept mapping) (Pintrich & Garcia, 1991). The use of active learning strategies (Schraw, Crippen, & Hartley, 2006) such as graphs and tables occurs in the performance phase.

One of Zimmerman's 14 categories of SRL strategies is transformation of information (Zimmerman & Martinez-Pons, 1988). Such transformation of information involves students in the representation of concepts and their interconnections, a skill that underpins deep learning. Cognitive organisers are visual tools that assist learners represent facts, ideas, concepts and the connections between them (Feden & Vogel, 2003). The use of organisers increases the likelihood that declarative knowledge, what strategies are, will be retained in long term memory in an understandable and retrievable form (Feden & Vogel, 2003). Cognitive organisers such as those modeled and used in the MHS GTSP are examples of active cognitive strategies that assist the organisation and transformation of information (Zimmerman, 1989b; Zimmerman & Martinez-Pons, 1990). Research by Hattie and Purdie (1998) found that integrating the informed use of study strategies to suit the content and used for near transfer in context, was particularly useful with high ability students. It follows that those teaching methods and assessment practices that promote the use of cognitive organisers facilitate deep learning. Such practices as they exist within the GTSP are a focus of Research Question 1.

Examples of cognitive organisers are: graphic organisers, concept maps and mind maps (Feden & Vogel, 2003). Graphic organisers are tools for structuring thinking (Lochhead, 2001). They are diagrammatic outlines containing visual or verbal prompts which help students organise their thinking to form more abstract comparisons, evaluations and conclusions (Parks & Black, 1992). Organisers as "visual tools offer a bird's-eye view of patterns, interrelationships and interdependencies" (Feden & Vogel, 2003, p. 81).

Feden and Vogel (2003) indicate that particular types of organiser assist low level thinking. For organising content information, a retrieval chart, time line or graph may be appropriate. For higher order thinking other organisers are more effective, such as a Venn diagram for compare and contrast tasks. Recent studies in classrooms show questions in class are 20% organisational, 60% recall, with only 20% higher order questions (Feden & Vogel, 2003, p. 118). Gifted and talented students need to be exposed to a greater percentage of higher order questions (Macleod, 2005). The use of the organiser: ‘Fat and Skinny Questions’, elicits the higher level questions of Bloom’s taxonomy such as analysis, synthesis and evaluation (Taber & Corrie, 2007).

Schemata refer to the network of ideas and relationships that an individual uses for learning. Concepts are linked into a hierarchical network of higher and lower order substantively related schemata and these can be represented as a concept map (Biggs & Moore, 1993). A concept map is a two dimensional diagram that represents the relationships between a number of concepts (Schraw, Crippen, & Hartley, 2006). Elements of the content may be arranged in hierarchical order. A line is drawn between each pair of concepts to show the linkage. Networking (a form of concept mapping) requires a diagram with nodes and links and descriptions of the links between ideas (McInerney & McInerney, 1998). Drawing or reading a concept map forces the learner to consider the links (Taber & Corrie, 2007) which in turn brings related elements of a phenomena into consciousness which therefore elaborates the schema and broadens understanding (Lochhead, 2001).

> Concept maps show the infinite permutations of concepts and propositions that can be organised to explain any given phenomenon; they can be a powerful tool for helping students to understand the meaning of the constructed nature of knowledge. (Biggs & Moore, 1993, p. 328)

However, making use of concept maps is not without difficulties. A great deal of training is required before students can use concept maps proficiently. A concept map may simultaneously represent many kinds of relationships such as: conceptual relationships, and cause and effect, which are linked by lines and words. The complexity of such maps may make it difficult for the student to access the relationships and use the map effectively (McInerney & McInerney, 1998).

Conceptual growth involves the addition of new knowledge to a pre-existing conceptual framework. In Piaget's terms, it is analogous to the process of assimilation. Conceptual change occurs by cognitive restructuring, this is comparable to Piaget's idea of accommodation (Duit & Confrey, 1996). Deep understandings of phenomena are indicators of conceptual change. Conceptual change only occurs when conditions support it, such conceptual change takes time as is difficult to accomplish (Duit & Confrey, 1996). Unfortunately traditional methods of teaching fail to promote the understanding of, or ability to use, information which is vital to conceptual growth and conceptual change (Feden & Vogel, 2003). Teacher modelling and students practising with cognitive organisers such as concept mapping can assist in this regard (Taber & Corrie, 2007).

A number of outcomes are possible as students use a particular organiser, but they all make use of the powerful strategy of organisation (Feden & Vogel, 2003). According to Feden and Vogel (2003, p. 139):

> organisers assist students: in active thinking about textual information to promote understanding of content; store and retrieve information to make information meaningful; learn how concepts fit with their prior knowledge; organise, reorganise, revise, modify the connections as they process information; think at higher levels by providing scaffolds to help with cognitive operations; and understand how concepts will be used, applied and transferred in novel situations. Organisers assist teachers to access what students are thinking and how they are thinking; and, provide opportunities for student to student and student to teacher communication.

Another cognitive strategy involves aspects of resource management such as study time, environment and management of others (Pintrich & Schrauben, 1992). Help-seeking is a feature of students who self-regulate. Various perceptions of the classroom will affect how comfortable students are in seeking help. Students who relate well to their teacher and who perceive that their teacher is involved with their learning are likely to engage more readily and ask questions. Cooperative learning, a feature of a constructivist instructional approach, also facilitates help seeking (Ryan & Patrick, 2001; Schraw, Crippen, & Hartley, 2006). Classroom goal orientation also has an effect; help seeking being more likely where mastery is emphasised rather than performance (Ames, 1992b; Ames & Archer, 1988; Newman & Schwager, 1992). Gifted and talented students generally seek more assistance from adults, particularly parents, than age related peers (Zimmerman & Martinez-Pons, 1990). Thus parents can have a significant, direct impact on their child's self-regulation and an indirect effect on their academic achievement (Maehr & McInerney, 2004; Zimmerman, 2004). The effect of the GTSP on the use of SRL strategy particularly in relation to assessment tasks was the focus of Research Questions 2 and 4, examined through participant observation, focus group interview and one-on-one interviews.

Biggs (2003) considers the development of the self-management skills of SRL an essential life-skill and suggests that study skills be included as part of the curriculum to support knowledge building. In relation to SRL, students need to develop: declarative knowledge (what strategies are), procedural knowledge (how to use strategies) and conditional knowledge (knowing when and why strategies work) (Paris & Byrnes, 1989). However, even when a range of strategies is taught, students choose and use only surface ones, or reject deep ones if that is all they perceive is required for the assessment of a course (Biggs, 2003). Research by Ames and Archer (1988), using data from academically advanced students exposed to a study skills program, indicates that the perception of a mastery oriented classroom is crucial to students adopting adaptive SRL strategies. More contemporary research regarding self-regulation in science education focuses on strategy instruction which emphasises the specific teaching of cognitive, problem solving and critical thinking strategies (Schraw, Crippen, & Hartley, 2006).

In general, students are not strategic in their learning because they do not monitor their learning with a view to understanding which strategies have been effectual. They therefore resort to well practised routines even if these are ineffectual in enhancing learning. Often the student may not understand the complexity of the demands of the task and therefore is unable to choose an appropriate aligned strategy. The inappropriate attributions of surface learners to ability, rather than effort, do not support involvement in strategy use (McInerney & McInerney, 1998).

The self-reflection phase of the cycle of self-regulation (Zimmerman, 2004) involves metacognition (Figure 2.8) which relies on a student being aware of and understanding their cognitive processes (Pritchard, 2005; Vialle, Lysaght, & Verenikina, 2005). Students judge their personal effectiveness, from observations of prior performance (Zimmerman, Bonner, & Kovach, 1996). Subsequently, they derive their own strategies directed at coping with learning in the school context (Biggs & Moore, 1993). It is to be noted that in Biggs' 3P model (Figure 2.3) he uses the term metalearning to describe the specific application of metacognition to the area of student learning (Biggs & Moore, 1993).

Metacognitive tools help students monitor their state of thinking with respect to the subject matter. Examples of metacognitive tools include concept maps, flowcharts, semantic networks, Vee diagrams and KWL charts. Such tools initiate reflection, dialogue and restructuring of a student's understanding. They also assist with the retention and recall of knowledge. However, it takes about two months and 10 constructions for a student to feel comfortable with a particular scaffold (Wandersee, 2001). Furthermore, the estimated time it takes to become expert in a particular area is estimated at thousands of hours (Miller, Heafner, & Massey, 2009) with provision of support by teachers. Self-regulated learners make metacognitive connections between cognitive strategy use and learning outcomes (Marton, 1988; Pintrich & Garcia, 1991; Zimmerman & Martinez-Pons, 1992). Metacognition activates the use of metacognitive strategies from the individual's 'toolkit', it is like a 'gallery walkthrough', following which the student can select the most appropriate strategy for the task at hand (Wandersee, 2001). The metacognitive category of self-regulated learning strategies which is used to monitor progress is vital to the transfer of strategies to appropriate situations (Zimmerman & Martinez-Pons, 1988). Self-regulated learners identify the direct effects of their choice of strategy on the outcomes of the leaning process as shown in Figure 2.7. Active engagement in learning results in increases in academic performance (Ablard & Lipschultz, 1998; Coutinho & Neuman, 2008; Pintrich & De Groot, 1990). Self-regulated learners take greater responsibility for their achievement as they relate proficiency with strategy use that is under their control (Purdie, Hattie, & Douglas, 1996). Thus, the acquisition of SRL is crucial to the academic success of students (Taber, 2007a).

Metacognitive strategies may be used for the planning, monitoring and regulating of learning. Planning involves goal setting for studying, skimming text, question generation prior to reading and task analysis of problems. Metacognitive activity helps a student to plan their cognitive strategies and activate relevant aspects of prior conceptual schema making them available for organising and comprehending material. Monitoring strategies are used to: focus on comprehension, track one's attention and self-test. Regulation strategies are tied to monitoring, examples include rereading a passage slowly after recognising lack of understanding, reviewing forgotten course material, missing test questions in an examination, but then returning to them (Pintrich & Garcia, 1991).

Metacognitive tools such as concept maps help students monitor their state of thinking with respect to the subject matter. Such tools assist with reflection on and restructuring of the students' understanding and help with the retention and recall of knowledge (Wandersee, 2001). Without reflection, students may only use a tool in the context in which it was introduced. With reflection a student's conditional knowledge is improved. "Thus graphic organisers become a metacognitive tool to transfer the thinking processes to other lessons which feature the same relationships" (Parks & Black, 1992, p. 2).

Self-Regulated Learning, Learning Approach and Gifted Learners

> Having appropriate goals is just one aspect of successful performance; students must also be equipped with appropriate cognitive and self-regulatory strategies for accomplishing the academic tasks in college classrooms. (Pintrich & Garcia, 1991, p. 399)

Goal orientation predicts metacognitive awareness and the use of cognitive and metacognitive strategies. A student's goal orientation is assumed to be understood by the individual, in that they are aware of the reasons for engaging in a task and what they are trying to accomplish (Boekaerts & Cascallar, 2006; Pintrich, 2000). A deep approach is the most adaptive, as it is associated with a long term, higher rate of strategy use and with meaning oriented strategies (Ames & Archer, 1988; Maehr & McInerney, 2004; Meece, Blumenfeld, & Hoyle, 1988; Pintrich & De Groot, 1990; Pintrich & Garcia, 1991; Purdie, Hattie, & Douglas, 1996). In situations where assessment takes the form of multiple choice tests, it is perceived that low quality learning is rewarded, which leads to superficial rote level processing strategies in students with an achieving approach (Biggs, 2002; Maehr & McInerney, 2004; Wilding & Andrews, 2006).

Teachers' epistemological beliefs affect their curricular and pedagogical decision making. Two world views coexist. Realism corresponds to a belief that knowledge is relatively simple, fixed and can be taught with a one size fits all approach. Relativism corresponds to a belief that knowledge is messy, changing and is personalised through one's experiences (Schraw, Crippen, & Hartley, 2006). A student's learning approach is founded on their epistemological beliefs and this has implications in their ability to self-regulate their learning (Schraw, Crippen, & Hartley, 2006). Since teachers can manipulate contextual messages in the classroom, goal theory has implications for classroom practice in relation to SRL (Ames, 1992b; Ames & Archer, 1988; Brophy, 1999). It appears gifted children are more affected by their teachers' attitudes and actions than others and contrary to common belief such students need specialised guidance to succeed (Park & Oliver, 2009).

Although recent research has shown that students with a deep approach exhibit greater use of SRL strategies (Cowan, 2002), there are a number of findings that indicate the facilitative nature, on SRL strategy use, of an achieving approach combined with deep approach (Ablard & Lipschultz, 1998; Ames, 1992b; Midgley, Kaplan, & Middleton, 2001; Pintrich, 2000). Researchers with a multiple goals perspective are examining the dichotomy between memorisation and understanding in normative goal theory, so that use of both approaches can be viewed as complementary rather than antithetical (Harackiewicz, Pintrich, Elliot, & Thrash, 2002; Purdie, Hattie, & Douglas, 1996). The degree to which students with identified learning approaches used cognitive and metacognitive strategies, as a result of scaffolding in GTSP classes, was examined by participant observation, focus group interviews and one-on-one interviews to address Research Question 4.

Although high achieving students use more self-regulating strategies than low achievers, they rarely use all aspects or all 14 types of strategy as classified by Zimmerman (Purdie, Hattie, & Douglas, 1996; Zimmerman, 1989b; Zimmerman & Martinez-Pons, 1990). Reis (2004) suggests that a lack of SRL is a feature of gifted underachievers who have not experienced significant early curriculum challenge. Students who have been provided with a curriculum that allows them to work within their current capabilities are not challenged to develop the skills facilitated by opportunities to work within their zone of proximal development (Taber, 2007b). As many as 15-40% of identified gifted students are at risk of performing below their potential (Rayneri, Gerber, & Wiley, 2006). The provision of ample opportunities to practise such SRL behaviour is highlighted by research (Miller, Heafner, & Massey, 2009). Scaffolding, especially in the area of metacognition, is essential for gifted and talented students (Smee, 2005; Taber & Corrie, 2007). It take about 10 personal constructions for a student to feel comfortable with a particular scaffold such as concept mapping (Wandersee, 2001). Teachers need to instruct students in the use of task strategies, prompt students to use certain strategies (Cekolin, 2001) and communicate to students that strategies are learnable and under their control, contributing to feelings of self-efficacy (Pintrich & Schrauben, 1992). Students with a high sense of self-efficacy are more likely to use rehearsal, elaboration and organisational strategies (Pintrich & Schrauben, 1992).

Self-Efficacy of Learning

Self-efficacy is defined as a sense of confidence regarding the performance of particular tasks (Bandura, 1997; Jinks & Morgan, 1999). “Assuming adequate skills, positive outcome expectations, and valued outcomes, self-efficacy is hypothesised to influence the instigation, direction, and persistence of much human behaviour” (Schunk, 1991. p. 94). The construct can be applied in the context of learning in classrooms, hence self-efficacy of learning. There is no fixed relationship between the beliefs of self-efficacy and self-esteem, which is concerned with judgments of self-worth. A sense of personal efficacy predicts the goals and performance outcomes of an individual, whereas self-esteem affects neither (Bandura, 1997).

Self-efficacy is an intrapersonal variable that affects the translation of gifts into talents (Figure 2.7). Self-efficacy is an integral construct in social cognitive theory and a key variable in the development of SRL (Bandura, 1997; Pajares, 2002; Zimmerman, 2004; Zimmerman, Bonner, & Kovach, 1996). Socio-cognitive learning theory indicates that the relationship between self-efficacy and SRL is reciprocal. A high sense of self-efficacy affects the forethought, performance and self-reflection phases of SRL, through student use of more effective cognitive and metacognitive strategies (Schunk, 1991; Schunk & Pajares, 2004; Zimmerman, 1989a; Zimmerman, Bonner, & Kovach, 1996; Zimmerman & Martinez-Pons, 1992). "Self-efficacy beliefs grow as they [students] become more self-regulatory until they like the Confucian fisherman, could personally feed their hunger for knowledge for a lifetime" (Zimmerman, Bonner, & Kovach, 1996, p. vii).

Teachers have a role of helping students to develop positive self-efficacy and regulatory habits that will self-perpetuate (Pajares, 2002). The quality and nature of teachers' relationships with students plays a strong role in facilitating adaptive motivational beliefs. Self-efficacy is strengthened when students think accomplishment is a result of ability and effort. This is more likely if students negotiate tasks and personalise goals (Patrick, Gentry, & Owen, 2006). However, challenging tasks must be accompanied by appropriate scaffolding (Turner & Meyer, 1999). Feedback must be referenced to students' previous efforts to improve self-efficacy and facilitate a mastery approach (Patrick, Gentry, & Owen, 2006).

Students appraise their self-efficacy by assimilating personal, environmental and behavioural factors. Appraisal of one's capabilities is generally the result of social comparisons, self-efficacy being enhanced in situations where performance is superior in relation to group norms. Self-efficacy varies substantially depending on the talents of those chosen as the basis of comparison (Bandura, 1997). Pajares (2002) suggests that individualised classroom learning environments, rather than competitive traditional classrooms, are more likely to foster positive perceptions of self-efficacy. Gifted students can exhibit a strong need for high achievement, accomplishing difficult tasks and overcoming obstacles can enhance their feelings of self-efficacy (Sekowski, Siekanska, & Klinkosz, 2009) Vicarious observation of classmates' achievement can promote self-efficacy in observers. The effectiveness of such observations is enhanced if the observer can describe the learning strategies that were used (Schunk, 1991).

Students’ self-efficacy beliefs affect their academic attainment (Bandura, 1997; Hong & Aqui, 2004; Pajares, 2002; Zimmerman & Martinez-Pons, 1990). Students with a high sense of efficacy are likely to choose more difficult tasks, expend greater effort, persist longer, apply appropriate problem solving strategies and have lower task anxiety than those with a low sense of efficacy (Pajares, 2002; Rueda & Dembo, 1995; Schunk, 1989).

Student giftedness is generally associated with high levels of academic self-efficacy (Hong & Aqui, 2004; Sekowski, Siekanska, & Klinkosz, 2009; Zimmerman & Martinez-Pons, 1990). Students in the general population are inclined to over-estimate their ability to solve problems, in the mathematics problem solving context, gifted girls are however more likely to under- estimate their ability. In general, gifted students are more accurate at gauging their efficacy than regular learners (Pajares, 1996).

The academic milieu of the GTSP affects students’ feelings of self-efficacy and their use of SRL strategies (Zimmerman & Martinez-Pons, 1990). Highly gifted students can fail to reach their potential in circumstances where their perceptions of their self-efficacy are compromised (Bandura, 1997). Research Question 2 addresses the effect of participation in the GTSP on self-efficacy of learning.

To assess students’ perceptions of their self-efficacy, a scale from an instrument used in conjunction with the Technology Rich Outcomes Focused Learning Environments (TROFLE) developed by Aldridge, Fraser and Fisher (2003) was used for this research. The Academic Efficacy Scale was modified from the Morgan-Jinks Student Efficacy Scale (MJSES) developed by Jinks and Morgan (1999). A more detailed description of the self-efficacy measure follows in the research methodology chapter.

The journey of a gifted student towards demonstration of talent is affected by intrapersonal catalysts. The relationships between the intrapersonal factors of self-regulated learning, learning approach and student self-efficacy, as discussed previously in this chapter, are represented in the conceptual framework for this research (Figure 2.12). Autonomous use of cognitive resources is essential to problem solving which lies at the heart of attainment of scientific literacy and life-long learning by students and is developed in a sociocultural milieu (Boekaerts, 1996; S.M Reis, 2004; Smee, 2005; Zimmerman, 2004). The classroom environment of the GTSP as an environmental catalyst, as represented in the conceptual framework is explored in the following section. The classroom environment section discusses: milieu in general, classroom environment measures, provisions in relation to the teaching practices within the GTSP, constructivism and evidence of achievement.

Environmental Catalysts

The importance of environmental catalysts in the translation of a student's gift into talent is acknowledged in Françoys Gagné's differentiated model of gifts and talents (Gagné, 2006, 2010) (Figure 2.1). In this section the concepts of milieu with respect to classroom environment, educational provisions, constructivism and evidence of achievement are discussed.

A Sociocultural Approach to Self-Regulated Learning

The developmental approach to thinking skills of Jean Piaget considers that cognitive abilities increase with age, environment playing a role through the deliberate actions of the learner (Taber & Corrie, 2007). Much scientific thinking requires abstract thought which requires a learner to be at the stage of formal operations according to Piaget (Taber & Corrie, 2007). The sociocultural approach to self-regulated learning (SRL) based on Bandura's social cognitive learning theory (Schunk, 1989; Vialle, Lysaght, & Verenikina, 2005), stresses the importance of aspects of learning based on the theoretical framework of Vygotsky, which indicates that "cognition is not situated solely within the individual without reference to the social and cultural contexts within which the actions take place" (Rueda & Dembo, 1995, p. 266). Research shows that students' conceptions of learning and use of strategies vary according to the educational context (Purdie, Hattie, & Douglas, 1996). As such an examination of the milieu to which the GTSP students were exposed is an important element in this research (Research Question 1).

According to Vygotsky, development can not be separated from the social context in which it occurs (Feden & Vogel, 2003). Vygotsky describes how higher order cognitive functions develop in the context of social interactions with more competent others, mentors or teachers, who provide scaffolding or assisted performance in meaningful learning tasks. That is, learning occurs in the zone of proximal development (ZPD). Scaffolding, or support over a teaching session, allows a student to carry out a task that they were not initially able to achieve on their own and leads them to a state of competence that enables them to achieve a similar task independently (Roth, 1999; Taber, 2007b). The process whereby the mentor and student come to shared understanding is called inter-subjectivity (Vialle, Lysaght, & Verenikina, 2005). Thus self-regulation is not acquired but "shaped and elaborated through participation in 'zones of proximal development' according to the tenets of sociocultural theories" (Paris & Paris, 2001, p. 96).

In order to examine students' motivation for learning, from a sociocultural perspective, activities within which students are observed learning in social contexts need to be analysed. Since behaviour cannot be separated from the setting in which it is constructed and displayed, a sociocultural approach requires a study in which the classroom activity setting is the focus (Boekaerts, 1996; Rueda & Dembo, 1995). The importance of a sociocultural approach is acknowledged by the Researcher, and as a consequence participant observation was used to examine factors impacting on learning 'inside the black box' of the classroom (Janesick, 2000; Patton, 2002). Participant observation was used to inform the Researcher in respect to Research Questions 1, 2 3 and 4. Whilst the milieu of the students in the GTSP is understood by the Researcher to extend beyond the confines of the classroom, the scope of this research limits discussion to the classroom context within the GTSP (Research Question 1) and those specific descriptions of social and home milieu that were discussed during one-on-one interviews in relation to self-regulated learning practices (Research Questions 2 and 4).

Classroom Environment

> It is not only understanding of science and mathematics content that matters in constructivist approaches, but also issues of a satisfactory classroom climate. (Duit & Confrey, 1996, p, 89)

Fraser (1994) and Dorman (2002) advocate the use of classroom environment measures in evaluations of new curricula and teaching approaches. The GTSP was created to attend to the needs of a special group of students who may have been disenchanted and/or educationally under-developed through the classroom provisions made for them in the past. Person-environment fit research examines whether students do better when there is congruence between the students' preferred classroom learning environment and the actual environment. This research provided an opportunity to find out what preferences GTSP students had in terms of their learning environment and see if indeed these preferences were being reflected by the provisions afforded them within the MHS GTSP. This was the focus of Research Questions 1. Therefore, the concepts of classroom environment and person environment fit research were incorporated into the conceptual framework for this research as part of the environmental catalysts that impact on the development of gifts into talents (Figure 2.9).

Students' academic goals are influenced by their perceptions of the classroom context in which they operate (Mansfield, 2001). In relation to goal theory, in order to motivate students to learn, the classroom climate, curriculum, instruction and assessment practices must be coordinated so as to encourage a particular learning approach (Ames, 1992a; Biggs, 2002; Brophy, 1999; Meece, 1991; Urdan, Kneisel, & Mason, 1999). In constructive alignment, all critical components of a teaching context should be integrated towards deep learning (Biggs, 2003). A tight "fit' between the needs of adolescents and the classroom environment facilitates optimum motivation (Turner & Meyer, 1999) and influences social and academic goals (Mansfield, 2001).

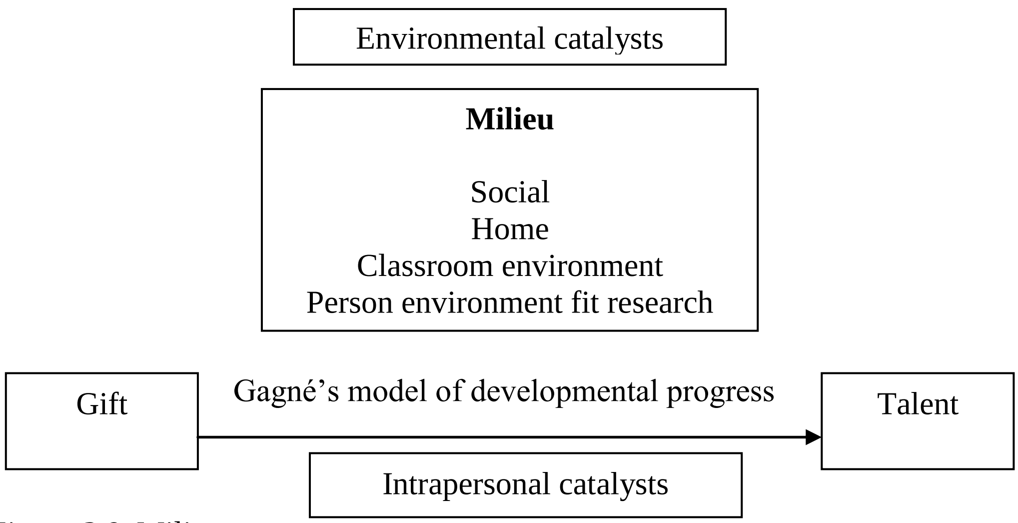

Figure 2.9. Milieu.

Teachers' philosophical beliefs affect their curricular and pedagogical decisions. Teachers plan, monitor and assess individual and group learning in the moment of teaching (Van Tassel-Baska, Quek, & Feng, 2007). A teacher who emphasises learning over performance instills in the students the idea that mistakes are a normal part of learning and encourages risk-taking, promoting a deep learning approach (Pajares, 2002; Raffini, 1993; Stipek, 1993). In such a classroom climate, the students have a more positive attitude towards the class, prefer challenging assignments, and believe that success follows effort (Ames & Archer, 1988). Teachers can also assist the students to develop a deep approach by helping them to experience the meaning of concepts vicariously (Ramsden, 2003). In classrooms emphasising the adaptive deep approach, science teachers relate the learning material to the students' interests, pose questions and problems in which the students apply knowledge, allow students to demonstrate knowledge in various ways (Scott, 2007), are better able to match tasks to the level of the students, use learning structures that reduce comparability of performance, and stress the intrinsic value of learning (Meece, 1991).

Research indicates that you cannot train a student to be a deep learner when the educational context is rewarding surface learners. Neither can students be trained to use a deep approach in a particular context, since an approach is not a skill to be utilised without regard to the nature of the subject matter they are learning (Ramsden, 2003).

> Students can no longer be passive passengers as they move through life on a course determined by the educators they have encountered in the past. They must be the cartographers, navigators and captains of their own development (Martens, 2004, p. 9).

Learning environment research began in the 1970s (Aldridge, Fraser, & Fisher, 2003). The dimensions measured are typically classified according to Moo's scheme: relationships, personal development, system maintenance and system change (Aldridge, Fraser, & Fisher, 2003). The GTSP aims to provide both academic and social support (Robinson & Britton Kolloff, 2006, p. 600) since "A supportive learning environment provides the intellectual, social and physical conditions in which effective learning can occur" (Curriculum Council, 1998, p. 36). A number of instruments specific to the evaluation of classroom environments in science are available such as the Science Laboratory Environment Inventory (Fraser, 1994; Fraser & Lee, 2009). However, the Individualised Classroom Environment Questionnaire (ICEQ) (Fraser, 1990) was chosen as an instrument for this research because its five dimensions are aligned to the principal foci of gifted education within the GTSP namely: *Personalisation, Participation, Independence, Investigation and Differentiation*. A detailed description of the ICEQ follows in the research methodology chapter.

The special provisions of the GTSP at MHS form part of the environmental catalysts that influence the developmental process (Figure 2.10). Van Tassel-Baska and Stambaugh (2006) suggest four aspects of curriculum are attended to for gifted and talented students: compaction, concentrating on higher order thinking, depth and interrelationships between bodies of knowledge and encouraging self-directed learning.

Educational Provisions

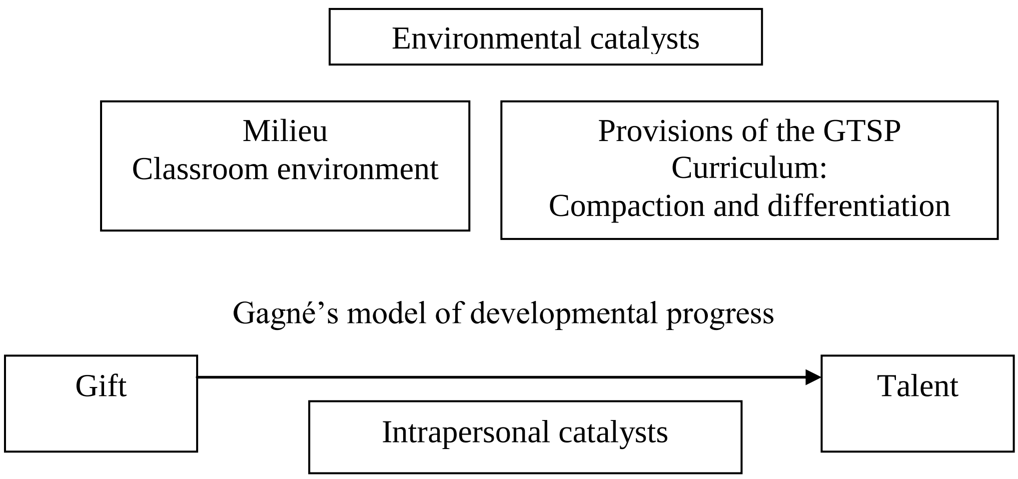

Figure 2.10. Educational provisions.

The special provisions within the GTSP at MHS include differentiation which addresses the students' different learning rates and approaches (Figure 2.10) (Macleod, 2005; Plowman, 1980; Smee, 2005). Differentiation for gifted students recognises the importance of curriculum, instruction and assessment (S.M. Reis & Morales-Taylor, 2010). The design of a differentiated curriculum recognises key features of general curriculum that can be tailored to ensure focus on meaningful experiences to facilitate depth and complexity of learning (Van Tassel-Baska, 2005; Van Tassel-Baska, Quek, & Feng, 2007). When the curriculum is differentiated, it is aligned, in respect to level of difficulty, with the intellectual capacity of the students such that they can work within their zone of proximal development. Differentiation must target the content, process and conceptual demands of the program (Van Tassel-Baska, 2005; Van Tassel-Baska, Quek, & Feng, 2007).

Students in the GTSP at MHS sit assessments common to the year cohort; as a result there is reduced flexibility within the curriculum to explore different concepts. However, rather than offering students different learning experiences, differentiation can occur through allowing variety in learner responses to the same open learning tasks (Hertzog, 2004). Differentiated instruction in the GTSP commonly takes place by setting tasks that allow students to work at their own pace to produce assessment products that reflect their preferred learning styles commensurate with their ability (S.M. Reis & Morales-Taylor, 2010). When differentiation is regarded in this manner, it also becomes viable to incorporate the instructional strategies which facilitate differentiation within heterogeneously grouped classrooms (Hertzog, 2004).

Compaction is used to accelerate the science curriculum in the GTSP. It utilises diagnostic pretesting and careful choice of teaching materials to avoid repetition and to allow time for extension activities (see Figure 2.10) (Macleod, 2005; Smee, 2005; Van Tassel-Baska & Stambaugh, 2006). It is process of compaction of the normal curriculum to which the GTSP students are exposed that provides the flexibility to pursue extension material and the authentic tasks (Taber & Riga, 2007) discussed in a later section.

Constructivism

Constructivism is an epistemological model of learning (Cobern, 1993). It supports the assumption that students are goal driven and actively pursue knowledge and construct schema in social settings based on prior knowledge, understandings and skills (Pritchard, 2005).

> Instead of representing science in the traditional format, as a large body of knowledge to be mastered, teachers should represent science as an evolving framework of concepts and conceptual relationships, which are constructed not discovered by the learner (Treagust & Chittleborough, 2001, p. 249).

According to Duit and Confrey (1996) and Wandersee (2001) reorganising curriculum and teaching for improvement reflects a number of assumptions. It is inappropriate to tell students what to think using a traditional, didactic, instructional model rather science knowledge should be seen by students to be the result of human construction. Formal and informal conceptions of science must be allowed to coexist (Prain & Hand, 1995). Less emphasis should be placed on de-contextualised content knowledge and more emphasis be placed on authentic learning situations (Taber & Riga, 2007) as discussed in a later section. There should be some negotiation about how classes are conducted and the content to be taught. Since time does not permit teaching of everything by hands on inquiry, subject matter should be used as a vehicle to promote student centred activities during which there is exchange of ideas, debate and negotiated understanding (Scott, 2007). Such constructivist pedagogy is consistent with outcomes based education as represented in the Curriculum Framework of Western Australia (Curriculum Council, 1998). Whilst schools exist to promote learning, teachers are the catalysts for such learning (Pritchard, 2005). A constructivist teacher focuses on promoting knowledge construction, emphasising student self-monitoring and the connection of ideas. They understand that the science understanding of each individual is unique, having been constructed in social contexts. A constructivist teacher assesses students' "cognitive baggage" (Wandersee, 2001), via pretesting and uses it as a starting point of teaching, guiding the student through their zone of proximal development (ZPD) which is the interface between current understanding and that which is just above the level of understanding of a given individual. As more importance is placed on differentiation, the impact of the zone of proximal development increases. The constructivist teacher is able to facilitate the translation of students' gifts into talents in accordance with Gagné's model (Gagné, 2006).

Constructivist classrooms require students to change from passive absorbers of information to autonomous, active team participants (Duit & Confrey, 1996; Vance & Miller, 1995). The nature of a student's personally constructed meaning is influenced by their ideas and beliefs about the science to be learned, teaching, learning and the roles appropriate to teachers and learners (Gunstone, 1995). In a constructivist classroom, a shift in the dynamics of classroom roles is necessary for students familiar with a more traditional context, this takes time, as student understanding of roles is derived from past experiences. There is considerable evidence that students at first will be perplexed and even resist a change to more constructivist based pedagogy as they are satisfied with methods that allow them to memorise facts (Duit & Confrey, 1996). This supposed shift in dynamics is the idea underpinning Research Questions 2, 3 and 4.

Since congruence between preferred and actual classroom milieu has been shown to enhance learning outcomes (Fraser, 1990), there is a case here for investigating whether there is congruence between the preferred classroom environment of the constructivist teacher and the students, since constructivist pedagogy is more likely to promote deep learning (Gunstone, 1995). Person environment fit research underpins Research Questions 2, and 4. The place of classroom environment as one of the environmental catalysts can be seen in the conceptual framework (Figure 2.12).

Evidence of Achievement

In constructive alignment, all critical components of a teaching context should be integrated towards deep learning (Biggs, 2003). One of the most critical of influences on teaching and learning is assessment practices (Biggs, 2003; Ramsden, 2003). "Assessment is the senior partner in learning and teaching. Get it wrong and the rest collapses" (Biggs, 2003, p. 164). The relationship between teaching and assessment practices is shown in Figure 2.11.

Tension in assessment practices may result in misalignment. If society places an emphasis on test scores and parents transmit this emphasis to their own children it results in conflicting views of what constitutes best practice in the classroom. In terms of maximising a particular student's performance, decisions about the zone of proximal development need to be made during the actual teaching and learning process, they are not determined by standardised tests (Feden & Vogel, 2003). Teachers face a dilemma, "Concern for understanding competes with concern for covering the curriculum and testing what has been 'covered'" (Russell, 1993, p. 248). Within MHS all students, including those in the GTSP, sit Common Assessment Tasks (CATs) the grading of which is norn-referenced. These high stakes assessments limit the extent to which teachers within the GTSP are free to choose their own methods of assessment.

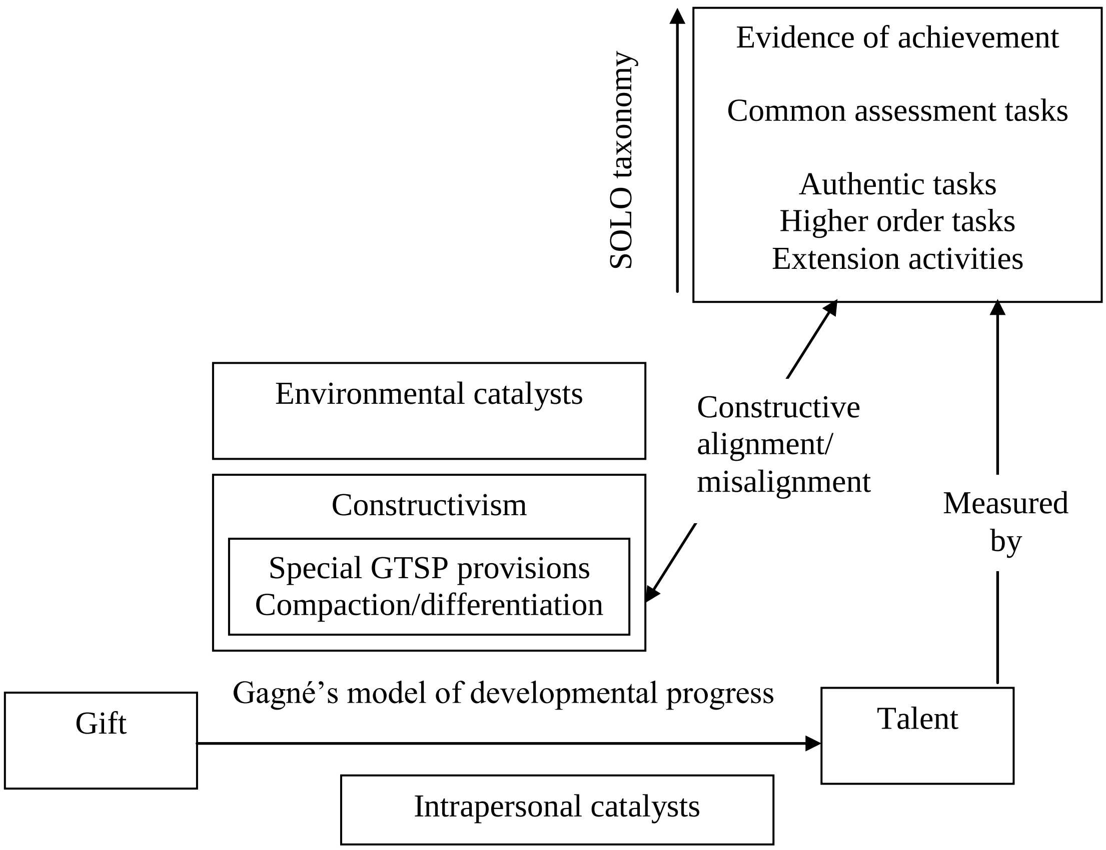

Figure 2.11. Evidence of achievement.

For the teacher the assessment practices within their educational institution define the actual curriculum. Yet, two different assessment worlds appear to coexist, an overt one as defined by the teacher and the curriculum and a covert one as defined by the students’ perceptions of assessment requirements (Ramsden, 2003) Students adapt to the requirements that they perceive their teachers make of them. The students’ evaluation of the situation may make earning high grades in tests more important than understanding the material. Thus, they may be pushed away from the type of learning they would like towards inappropriate surface approaches to appease teachers and assessment demands (Biggs, 2003; Ramsden, 2003). Backwash is the result of assessment driven learning rather than learning defined by the curriculum (Biggs, 2003).

> Nothing undermines open, authentic curriculum more than closed, artificial assessment, because assessments are, among other things, the means students use to determine what teachers really want them to *learn.* (S. Gallagher, 2006, p. 450)

Two types of backwash effects are described by Biggs and Moore (1993): cognitive backwash and affective backwash. Cognitive effects describe the strategies employed by students in learning for a test and strategies of approaching the test itself. Cognitive backwash also affects teaching as high stakes testing may result in teachers packaging the content according to what they think will be tested. Affective backwash is the emotional reaction of students to the prospect of testing. This will depend on the students' motivational orientation, the learning context and the test itself. Affective backwash results in less detrimental affects where assessment is criterion referenced as opposed to norn-referenced (Biggs & Moore, 1993). Affective backwash plays a role in students' perceptions of their self-efficacy of learning.

Whilst teachers hope to engage students in deep learning, traditional didactic teaching methods are more likely to involve students in superficial engagement with material (Feden & Vogel, 2003), thus the teachers of the GTSP are selected on the basis of their constructivist teaching philosophy. In addition, many assessment methods do not test understanding, although educators would like to think that they do. Students may succeed despite using a surface approach, or may not be given the opportunity to display the full range of their understanding if assessment procedures are lacking (Ramsden, 2003). Teachers are held accountable for the success of their students, consequently they face the dilemma of foregoing what they consider to be best practice in teaching and assessment for short term rewards in their students' test results. Teachers who cling to their constructivist ideals may face students that rebel when they deemphasise assessment in favour of more meaningful learning (Russell, 1993).

Standardised tests which often tend to measure trivial facts and fail to assess higher order thinking are still used widely, possibly since questions of fact are easier to develop. Also such tests are time efficient, in terms of student output, as students do not need time to think through problems or construct responses (Feden & Vogel, 2003). This is an important consideration in the context of high schools where testing may occur within a limited timeframe. In order to support higher order thinking skills, assessments need to involve integration and application. Integration is the process by which students make connections between the subject matter they know and the new information to which they have been exposed.

To an extent, integration is supported by state and national level science and mathematics tests to which the GTSP students are exposed by way of extension such as the International Competitions and Assessments for Schools Science**.** Such tests require connections to be made between material on the curriculum and higher order questions posed on the test. Feedback data from the institutions that construct these tests provide evidence of items that require interpretation and problem solving skills, however, the design of such tests is usually limited to a multiple choice format. Since there is evidence to suggest that students show a preference to assessment formats aligned to their learning approach predilection and since a multiple choice format is preferred by surface learners (Baeten, Dochy, & Struyven, 2008; Cassidy, 2006), the extent to which such competitions are engaging the deep learners is to be questioned. Evidence of achievement is examined by Research Question 3.

Application involves utilising current knowledge to learn more, understanding real-life events and using knowledge to solve problems (J. Gallagher, 1993). Robinson and Britton Kollof (2006) suggest that traditional tests and tasks such as research assignments do not adequately measure the outcomes of an appropriately differentiated curriculum. Best practice in terms of assessment for gifted and talented students lies in the use of authentic assessment tasks which pupils can relate to their experiences inside and outside of school. Authentic tasks involve students in the processes and problem solving which an experienced practitioner would undertake (Pritchard, 2005; Taber & Riga, 2007). Such tasks lead to a deeper level of student engagement than more traditional tasks. In order to complete an authentic task students need to have an understanding of facts, ideas and concepts, which is called declarative knowledge, as well as an ability to use their understanding, so called procedural knowledge (Feden & Vogel, 2003). Such tasks therefore promote both integration and application as advocated by Gallagher (1993). The use of authentic tasks to engage students in real problem solving, attends to the goal of problem based learning, “to make learning in school more closely parallel the life-long learning that occurs in adulthood” (Van Tassel-Baska & Stambaugh, 2006, p. 165). In the GTSP at MHS the intention is to use compaction of the curriculum to free up time to devote to authentic tasks (S.M. Reis & Morales-Taylor, 2010), which can then be used as a way of differentiating the curriculum (Figure 2.11).

Criterion based assessment rubrics used alongside authentic tasks are advocated by Feden and Vogel (2003). These rubrics clearly identify the criteria and standards for assessing student performance. As students engage with a specific task they are involved in thinking about the criteria that constitute an excellent performance, therefore they are involved in metacognition (Feden & Vogel, 2003) which is vital to self-regulated learning. The means of integrating the levels of the outcomes and standards framework (Department of Education and Training, 2005) within the assessment rubrics lies in an understanding of the SOLO taxonomy (Structure of the Observed Learning Outcome) (Biggs, 2002; Collis & Biggs, 1979).

The SOLO taxonomy (Collis & Biggs, 1979) is a hierarchy based on a study of outcomes in a variety of academic areas. It provides a systematic way to describe the stage at which a learner is operating when mastering academic tasks. Five stages can be identified: prestructural, unistructural, multistructural, relational and extended abstract (Biggs & Moore, 1993; Hattie & Purdie, 1998; Ramsden, 2003). The characteristics of engagement with a task, displayed by students at a particular stage, have been identified (Biggs & Moore, 1993; Ramsden, 2003). At the prestructural stage preliminary preparation for the task is evident, but the task is not engaged in an appropriate way. There is use of irrelevant information or no meaningful response is given at all. In the unistructural stage the focus is on one aspect of the task, there is no evidence of understanding the relationship between facts and ideas. Performance at the multistructural stage involves a focus on several features of the task, but there is no evidence of an interrelationship between aspects. At the relational phase several factors are integrated into a coherent whole that has structure and meaning and details are linked to conclusions. In the extended abstract phase the answer generalises a coherent structure, to a high degree of abstraction, beyond the information given which is based on a holistic understanding of the concept.

The SOLO taxonomy informed the development of the progress maps of the Western Australian Outcomes and Standards Framework (Hackling, 2003). The science progress maps (Department of Education and Training, 2005) describe eight levels of achievement that students can attain for each of four conceptual outcomes and one process outcome. The SOLO taxonomy, therefore, forms an important aspect of the conceptual framework for this research (see Figure 2.11).

For many years Bloom's taxonomy of educational objectives has been used to develop measures of achievement. The old version of Bloom's taxonomy (1956) proposes six levels: knowledge, comprehension, application, analysis, synthesis and evaluation. In the new version the order of the synthesis and evaluation levels are reversed. The CATs at MHS are still developed with reference to this new version of the taxonomy (Taber & Corrie, 2007). However, the Bloom's taxonomy supposes that there is a relationship between the level of a question and its answer, whereas SOLO does not. Bloom's taxonomy does not provide any criteria for judging the outcome of an activity. This can be a problem when a student gives a very superficial answer to what was seemingly an evaluation question or a deep response to a low order question (Hattie & Purdie, 1998).

If higher order thinking is to be one of the outcomes of learning, then authentic tasks must be carefully designed with regard to higher levels of cognitive processing (Taber & Corrie, 2007). The SOLO taxonomy is used by teachers of the GTSP at MHS to assist them to pretest, define curriculum objectives and evaluate science learning outcomes in relation to criterion referenced, open-ended authentic tasks (Biggs & Moore, 1993). Since the students may be working on individual or group tasks that demand different content knowledge, the SOLO taxonomy provides a way of assessing divergence in performance (Hattie & Purdie, 1998). Thus each child is given the opportunity to develop and provide evidence of knowledge and skills consistent with the SOLO taxonomy and the Western Australian progress maps.

A number of studies have shown a relationship between SOLO levels and approaches to learning such as that by Boulton-Lewis (1998), which concluded that as students move through the SOLO levels their concern with surface motives decline and they are more inclined to display deep motives and strategies. Students operating at the higher levels of the SOLO taxonomy tend to have higher scores on deep and achieving styles (Hattie & Purdie, 1998). Research by Van Rossum and Schenk (1984) (cited in Ramsden, 2003, p. 55) also indicated a relationship between approaches to learning and SOLO outcomes. This research found that students with a surface approach who see learning as a process of increasing knowledge were not able to give answers beyond the multistructural level, whilst deep learners were able to achieve a relational or extended abstract outcome. The deep approach reflects an intention to gain understanding by relating to a task in a way that facilitates links to personally held constructs (Ramsden, 2003). Where the aim of engaging in a task is to understand, a student needs to operate at the relational or extended abstract stages of the SOLO taxonomy (Hattie & Purdie, 1998).

Ability has some bearing on the use of different approaches, but it is control over one's learning, in this research defined as self-regulation of learning, that is probably the most important variable affecting learning approach (Biggs & Moore, 1993). A deep approach to learning orientation in gifted and talented students predicts their choosing challenging tasks that involve uncertain success, expending effort and persistence in their use of adaptive cognitive and self-regulated learning strategies. An optimally gifted student would therefore likely exhibit a deep approach to learning, have a high but not over-inflated self-efficacy, focus on problem solving, being strategic and self-monitoring and would seek assistance (Patrick, Gentry, & Owen, 2006). This research aims to interrogate the GTSP in respect to its aim of providing for the needs of gifted and talented students and facilitating their achievement of their potential (Taber, 2007a).

Conceptual Framework

The conceptual framework (Figure 2.12) attempts to synthesise all of the constructs determined by the literature that mediate teaching and learning in the context of a gifted and talented science program. Gagnés developmental model describes the journey of a gifted student towards demonstrations of talent. The Researcher has extended Gagné's developmental model to include relevant intrapersonal and environmental catalysts as examined by this study. The framework includes environmental catalysts such as milieu, provisions and evidence of achievement within the GTSP. The framework also includes intrapersonal catalysts such as self-efficacy, learning approach and self-regulation of learning and attempts to show the interconnections between these and the environmental catalysts in play within the GTSP. The possible conflict between assessment processes and the development of positive intrapersonal characteristics is indicated. The possibility of alignment or misalignment between teaching and assessment practices is included. Each of the constructs within the conceptual framework has been discussed in this chapter.

So in conclusion to this review of related literature it is the purpose of this Researcher to add to the body of research. Whilst there is much literature available on each of the factors that affect learning and indeed on the integration of such factors, there is a lack of research in regards to these interrelationships between these mediating factors in the context of science education for gifted and talented students in secondary school (Taber, 2007a).

The following chapter describes the research methodology. The epistemological stance of the Researcher and the methods required to collect data in relation to the research questions are discussed. The use of mixed methods to provide a means of triangulating data in the context of this study is also examined.

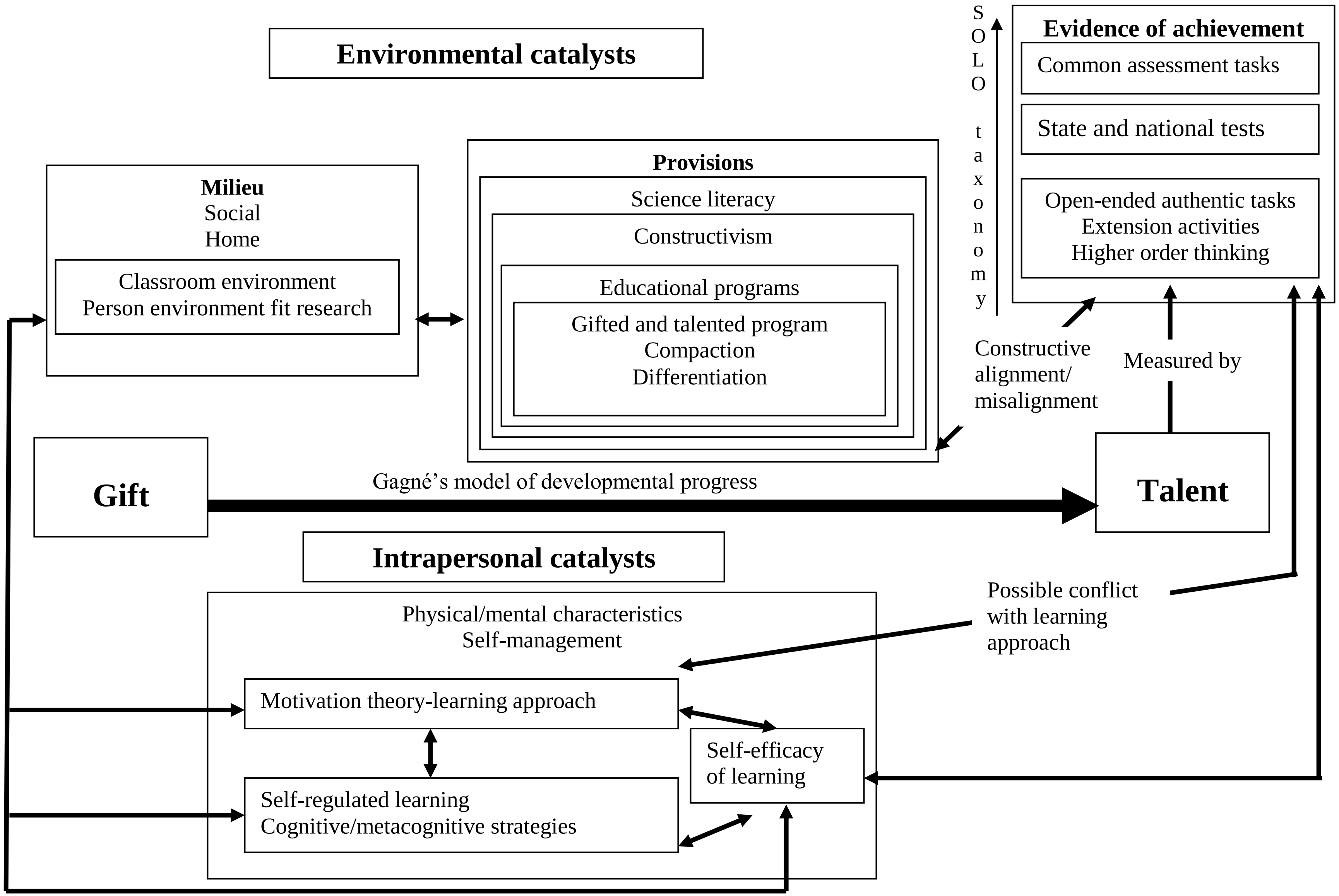

Figure 2.12. Conceptual framework.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter explains how the research was conducted. It begins with an explanation of mixed method studies and the justification for choosing this research approach. Classification systems for mixed method research in general are described and the research design for this study is delineated. Case study is then discussed with reference to the study. The quantitative methods, sampling process, measures and limitations are explained followed by the qualitative methods and sampling process. Methods of data analysis are outlined and finally compliance with research ethics is discussed.

Epistemological Underpinnings

This research used a mixed methods approach (Burke Johnson, Onwuegbuzie, & Turner, 2007; Cresswell & Plano Clark, 2011). Reliance on one method of data collection may have been seen to have introduced bias as ". . . research methods act as filters through which the environment is selectively experienced" (L. Cohen, Manion, & Morrison, 2000, p. 233). The mixed methods approach was conceived to suit the epistemological stance of the Researcher (an experienced science teacher), the specific research questions being addressed and the constraints of the context in which the research was undertaken, rather than being driven by any one strict methodological design. This approach allowed across methods triangulation to enhance confirmability and build as full a picture of the areas under investigation as time and circumstances permitted. A mixed method study combines qualitative and quantitative approaches at different stages of the research process. In this study qualitative data enhanced the quantitative data (Cresswell & Plano Clark, 2011). A mixed method study is a product of the pragmatist paradigm (Tashakkori & Teddlie, 1998). Mixed method studies are discussed in detail in a further section of this chapter.

Paradigms

Paradigms are the theoretical positions and belief systems that guide researchers; the positivist paradigm underlies quantitative methods, whilst the constructivist paradigm underlies qualitative methods (Tashakkori & Teddlie, 1998). The superiority of one or other paradigm has long been the subject of debate. Pragmatists propose that quantitative and qualitative methods are compatible. Pragmatists therefore use the method or methods most suited to their study believing that the research question is more important than either the methodology or the worldview that underlies it (Tashakkori & Teddlie, 1998).

Triangulation

The concept of triangulation, which involves combining data sources to study the same phenomenon, popularised the use of multiple techniques. Originally (1960s to 1980s) mixed method designs were promoted under the auspices of method triangulation (Tashakkori & Teddlie, 1998). Patton (1990) described three types of triangulation methods: within methods (using multiple qualitative data sources), across analysis (of qualitative data) and across methods (reconciling quantitative and qualitative data).

A review of the literature by Greene, Caracelli and Graham (1989) in relation to 57 mixed method studies from the 1980s indicated the following purposes for the use of mixed method research not limited to triangulation (seeking corroboration from different methods) but also including complementarity (examining different facets of a phenomenon); initiation (discovering fresh perspectives); development (one method informs the use of the second method) and expansion (adding breadth and scope to the study).

Classification of Mixed Methods Research

The presence in the literature of a number of typologies of mixed method research is to be expected since this mode of research is relatively new (Burke Johnson, Onwuegbuzie, & Turner, 2007; Mertens, 2005). Mertens considers a truly mixed approach as one which involves transformation of data and their analysis through another approach (Mertens, 2005). Tashakkori and Teddlie (1998) developed their classification system for mixed method research based on three dimensions. The measurement dimension includes qualitative and quantitative data collection and operations. The analysis dimension includes qualitative and quantitative analysis and inference. The type of investigation dimension distinguishes between confirmatory and exploratory investigations. Exploratory studies are stated in terms of research questions as opposed to confirmatory studies where there is at least one *a priori* hypothesis.

A simple dichotomous approach to the purpose of the research (confirmatory or exploratory) remains a major factor in defining mixed method research. Other key decisions described by Cresswell and Plano Clark (2011) are: the level of interaction of the strands; the temporal relation between the quantitative and qualitative data collection in the implementation sequence; the priority given to the qualitative and quantitative components (dominant, subdominant relations); and the stage at which the data and findings of the qualitative and quantitative components are integrated. Four basic mixed methods designs are discussed in the literature: convergent parallel, explanatory sequential, exploratory sequential and the embedded design (Cresswell & Plano Clark, 2011).

Classification of the Research Design

Yin (2003) defines theory as an understanding of what is studied. The theory operating that provided a guiding framework for the research design consisted of those conceptual understandings as detailed in the literature review. Specifically literature in relation to learning environment, learning approach, self-regulation of learning, self-efficacy of learning and gifted education guided this research into a Gifted and Talented Science Program (GTSP). It was the intention of the Researcher that further theory relating to the teaching of the gifted and talented in science in the secondary school context would result from an inductive process starting with the analysis of data. Thus the research was exploratory rather than confirmatory (Tashakkori & Teddlie, 1998).

Interaction relates to the way that quantitative and qualitative strands are integrated in a study (Cresswell & Plano Clark, 2011). In this research interaction occurred at the data collection phase, as the results of surveys were used for purposeful sampling of interview subjects and provided a lens during participant observation.

The priority given to qualitative and quantitative data was guided by the research questions, some of which necessitated the collection and analysis of quantitative data and some qualitative. However a predominance of quantitative data was collected overall due to the constraint of time. Consequently as a result of the weighting of methods to answer the research questions the study utilised a quantitative priority and may thus be labeled quantitative dominant (Burke Johnson, Onwuegbuzie, & Turner, 2007; Cresswell & Plano Clark, 2011). The qualitative methods were used to probe different aspects that could not be quantified (see Figure 3.1). The figure uses notation based on that of Tashakkori and Teddie (1998).

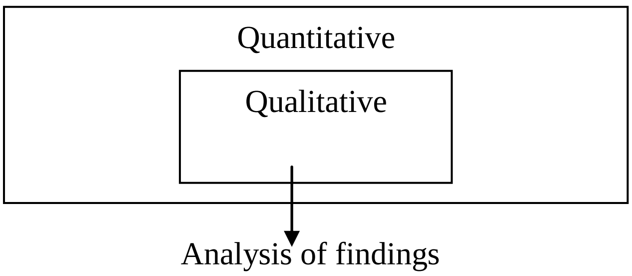

Figure 3.1. Quantitative priority (Cresswell & Plano Clark, 2011).

The research was a fixed mixed methods design since the data collection methods were predetermined at the commencement of the study and implemented as planned (Cresswell & Plano Clark, 2011). Timing relates to the temporal relationship between the quantitative and qualitative strands. This study did not occur in distinct interactive phases, however the collection of quantitative survey data using the Learning Process Questionnaire (Biggs, 1987a) occurred prior to recruitment of students with specific learning approaches for one-on-one interviews. The collection of this quantitative data did not inform the design for the next phase, but provided information about levels which were used to organise the collection of the qualitative data. Thus sequential timing was evident in this research (Cresswell & Plano Clark, 2011).

The results of qualitative and quantitative data collection were mixed during analysis to examine the Gifted and Talented Science Program (GTSP). Inferences made on the basis of the results of each stage were drawn together where appropriate to form meta-inferences (Mertens, 2005). For example, results from surveys, participant observations and one-on-one interview provided data for case studies describing the nature of the manifestation of various learning approaches in students identified by survey.

With reference to the prototypes of major mixed methods designs discussed by Cresswell and Plano Clarke (2011) and based on the decisions of interaction, timing, priority and mixing described, this research is most closely aligned to the embedded design. Case study has been added to enhance the research design as outlined in the next section.

Delineation of the Object of the Research and Case Study

Whilst Yin (2003) defines case study as a complex research strategy appropriate for the evaluation of a contemporary set of events over which the researcher has no control, Merriam (1998) indicates that the single most defining characteristic of case study is the object of the study. Stake (2000) also focuses on the case being studied in recognition of the problems associated with defining a case study as a form of research as discussed by Mertens (2005). Examination of a case can probe the complexity of relationships between the teacher, the curriculum, implementation of instructional strategies, and the classroom environment which influence the students' learning (Hertzog, 2004). "Educational processes, problems and programs can be examined to bring understanding that in turn can affect and perhaps even improve practice" (Merriam, 1998, p. 41). Accordingly, it was decided that the object of this research design, the case, would be the Gifted and Talented Science Program (GTSP) at Metropolitan High School (MHS).

In this study, the boundaries of the research are clearly defined (Merriam, 1998; Stake, 2000) as the Year 8 (2006) and Year 9 (2007) Gifted and Talented Science Program at Metropolitan High School. This was the object of intense analysis. The research questions related only to the GTSP and all relevant data were collected and organised in terms of this program (Kumar, 1999). The purpose of the research was to inform the teachers of the GTSP and the Researcher, but aspects of the results are transferable to other cases with similar contexts. The reader will be free to interpret the study and extend the generalisations to some population they have in mind because of their own experience and understanding (Merriam, 1998).

The design for this research was nested as individual cases provided data used to examine the GTSP the subject of the research as a whole. Analysis began with the individual cases (the lowest level possible) (Patton, 2002). Individual cases (n=11) were purposefully selected by criterion sampling for in-depth interviews (Patton, 2002; Stake, 2000). Data collected from a number of individuals (cases) with the same learning approach, as determined by the Learning Process Questionnaire (Biggs, 1987a) were examined to establish common themes, specifically to address Research Questions 2 and 4. Such a study is considered more robust than a single case study, as the multiple cases are analogous to replicates in experimental design (Yin, 2003). Similar findings were expected for students with a particular type of learning approach (literal replication) with predicted contrary results for students with a different learning approach (theoretical replication) (Yin, 2003). If two or more cases support the same theory, replication may be claimed, any generalisations made as a result are called analytic generalisation (Yin, 1994). The themes identified from analysis of the surface, achieving, deep and deep/achieving cases were then compared, this cross-case analysis added strength to the design (Yin, 2003) and formed part of the data for the GTSP case study (Patton, 2002).

In order to allow the Researcher to study selected aspects of the GTSP 'within the box' in depth and detail (Janesick, 2000; Patton, 1990) an eclectic mix of data forms were utilised in this exploratory, mixed method embedded design (Cresswell & Plano Clark, 2011) which added richness to the data set. Use of two or more methods of data collection about aspects of the GTSP allowed methodological triangulation to enhance the rigor of the research process (L. Cohen, Manion, & Morrison, 2000). It can be seen from Table 3.1 that the quantitative and qualitative techniques were triangulated for aspects of each of the research questions.

Quantitative Research Method

Research Participants

The research participants were all students in Metropolitan High School's Gifted and Talented Science Program 2006 and 2007 when they were in Year 8 and Year 9. The participants were members of a natural group consisting of students who were pre-assigned to the GTSP on the basis of a pre-existing variable, aptitude for science (Graziano & Raulin, 2004). In the year preceding entry into the GTSP in Year 8 (2006) students sat an entrance test; the Higher Ability Selection Test (HAST), produced by the Australian Council for Educational Research (ACER). The assumption was that high scores on the HAST suggest giftedness. The highest ranking students (n=26) were assigned to the Year 8 Gifted and Talented (G&T) class, the next ranking students formed the Accelerated Learning Program (ALP) class (n=26). These students also formed the top two classes of a gifted and talented mathematics program at MHS. In 2006 all consenting students from these two groups: G&T (n=21) and ALP (n= 17) participated in the research. In addition a number of other Year 8 students, many of whom had sat the HAST test, also consented to participate in the study (n=28). These consenting students increased the sample size for analyzing the reliability of measures (n=66). The teachers of the G&T and ALP classes were those pre-assigned to the classes and consented to being part of the study.

As can be expected in a school environment there were some changes in GTSP class composition between 2006 and 2007. In 2007 all Year 9 students in the G&T (n=28) and ALP (n=31) classes consented to participate in the study. Data had been collected from 19 of these students when they were in the Year 8 G&T class in 2006 (n=19). Several students in the Year 9 G&T class 2007 were new to MHS or had been moved into the class, of these some had been surveyed as Year 8 students in 2006 (n=4). The Year 9 ALP class 2007 (n=31) consisted of 22 students from the Year 8 ALP class (2006). Of the Year 9 ALP class 2007 a number of students had been surveyed as Year 8 ALP students in 2006 (n=14). Only one of the students entering the ALP class from outside of the GTSP in Year 9 2007 had been surveyed in 2006 (n=1). Thus there were a total of 38 students in the GTSP 2007 for whom quantitative data had been collected over the two year research period. However only 33 of these students remained in the same class over the two year research period, either the G&T class (n=19) or ALP class (n=14).

Table 3.1

Data Collection to Address the Research Questions

	Research Question	Data Collected
1	What is the nature of the teaching and learning context within the GTSP at MHS?	HAST[a] data, rICEQ[b] actual and preferred (student), rICEQ[b] actual and preferred (teacher), focus group interviews, teacher satisfaction poll, classroom observations
2	How and why do the experiences in the GTSP affect:	
	Learning approach	LPQ[c] and cLPQ[d] Pre and Post test, focus group interviews, classroom observations, one-on-one interviews, artefacts
	Self-regulated learning	Focus group interviews, classroom observations, one-on-one interviews, artefacts
	Self-efficacy	Self-efficacy measure, focus group interviews
3	What evidence of achievement exists for students in the GTSP to suggest they are reaching their potential and demonstrating talent in the field of science?	Focus group interviews, classroom observations, achievement data, artefacts
4	Is there variation among students in the impact of their participation in the GTSP	HAST[a] data, rICEQ[b] actual and preferred (student), LPQ[c] and cLPQ[d] Pre and Post test, self-efficacy measure, achievement data, focus group interviews, classroom observations, one-on-one interviews, artefacts

[a] HAST– Higher Ability Selection Test

[b]rICEQ – Revised Individualised Classroom Environment Questionnaire

[c]LPQ – Learning Process Questionnaire

[d]cLPQ – Combined Learning Process Questionnaire

Measurement Instruments

Self-completion surveys were chosen as the main form of quantitative data collection (see Table 3.1). They were an economical way of building up a broad picture of student approaches to learning, self-efficacy and psychosocial preferences (Moore, 2000). A pilot test was conducted in 2005 with Year 9 students (n=26) not involved in the research. The purpose of the pilot test was to determine how GTSP students responded to the administration of the surveys and to discover any difficulties in completing the surveys under similar conditions to the research method proposed. Modifications to the survey instruments in light of the results of the pilot were made where appropriate. The consent rate for the pilot study was 87%. The consent rate for the actual research varied, Year 8 G&T 2006, 81% (n=21), Year 8 ALP 2006, 65% (n=17), Year 9 G&T 2007, 100% (n=28), Year 9 ALP 2007, 100% (n=31).

Learning Approach Measures

Learning process questionnaire

"A student's approach to learning is a composite of a motive and an appropriate strategy" (Biggs, 1987a, p. 2). The three approaches to learning: deep, achieving and surface were previously described in Chapter 1. The Learning Process Questionnaire (LPQ) (Biggs, 1987a) operationalised these approaches for the purpose of this research.

The LPQ (Biggs, 1987a) is a 36 item self-report questionnaire that provides information on three basic motives for learning and three learning strategies that together form three approaches to learning: surface, achieving and deep (see Appendix A for the LPQ questionnaire and answer sheet). There are six subscales on the LPQ: surface motive (SM), deep motive (DM), achieving motive (AM), surface strategy (SS), deep strategy (DS) and achieving strategy (AS). There are six questions for each subscale. Respondents rate themselves using a five point scale, from 5 'this item is always or almost always true of me' to 1 'this item is never or only rarely true of me'. All items are scored in the same direction. The range of scores for each of the subscales varies from 6 to 30. Trials indicated that reversing the scores for certain items did not increase the reliability (Biggs, 1987a).

Determination of test-retest reliability involves statistical analysis by correlation to assess the degree to which a measure gives similar results when given to the same population on two separate occasions. In data provided on the LPQ by Biggs (1987a) two tests were administered that were separated by a period of four months. In the case of attributes such as learning approach, however, one would wish for some change as the result of an intervention program and this is what was found when the test was subjected to tests of reliability. Test-retest reliability was deemed reasonable because the ordering of students' test results remained similar in sampling (Biggs, 1987a).

Internal consistency measures the extent to which items in each subscale are measuring the same thing. The internal consistency was measured using alpha coefficients (Biggs, 1987a). A high Cronbach alpha coefficient indicates that the questions in the subscale reflect only one attribute. A subscale with a low alpha coefficient would indicate that the items are measuring more than one attribute. The internal consistency of the LPQ is satisfactory, with surface motive showing the least consistency since this subscale is less conceptually pure in that it included both positive and negative aspects of extrinsic motivation (Biggs, 1987a; Kember, Biggs, & Leung, 2004). The Study Process Questionnaire (SPQ) used with tertiary students has also been analysed for internal consistency and recommended for use with Australian students. Since the two questionnaires are very similar, the endorsement is extended to the LPQ (Biggs, 1987a). LPQ test-retest reliability and internal consistency data as published by Biggs are reported (see Appendix B).

On completion of the pilot study in 2005 internal consistency data was calculated (see Table 3.2.). Surface motive ($\alpha = 0.43$) and surface approach ($\alpha = 0.49$) subscales showed only satisfactory internal consistency, however, the decision was made not to alter any of the survey items as Biggs (1987a) provides norms for LPQ scales for students aged 14 which can be used as a basis of comparison for assigning learning approaches. By using the standard LPQ, student scores on each dimension could be converted to deciles using published data (Biggs, 1987b) to determine how typical a student's score was in broad terms. Such classification of students by learning approach was necessary to address Research Questions 2 and 4. Therefore despite the published Cronbach's alpha values, the LPQ was used to survey student learning approaches in 2006 (Year 8) and 2007 (Year 9).

Table 3.2

Reliability Data for the LPQ Scale Score

		Internal consistency (alpha coefficients)		
		Published data[a] (age 14)	Pilot study 2005	Pretest 2006
Surface	Motive	0.46	0.43	0.59
	Strategy	0.51	0.59	0.58
	Approach	0.60	0.49	0.69
Deep	Motive	0.56	0.62	0.60
	Strategy	0.67	0.60	0.64
	Approach	0.76	0.72	0.78
Achieving	Motive	0.68	0.83	0.65
	Strategy	0.67	0.83	0.65
	Approach	0.77	0.86	0.78

[a]Published data (Biggs, 1987a, p. 23).

Revised learning process questionnaire

A revised version of the LPQ, called the Revised Learning Process Questionnaire Two Factor (R-LPQ-2F) was developed by Kember, Biggs and Leung (2004) that took into consideration more recent advances in understanding in approaches to learning. The R-LPQ-2F is a two factor version, with deep and surface approach scales, suitable for use in schools because of its brevity. Like the original LPQ, the R-LPQ-2F is hierarchical in structure; each approach to learning has motive and strategy elements. The R-LPQ-2F has 22 items distributed evenly between the main scales. Using sophisticated statistical techniques, Kember, et al. (2004) have shown that each subscale of the motive and strategy elements of the original LPQ was multidimensional rather than unidimensional. The two subcomponents of each subscale are shown in Table 3.3.

Kember et al. (2004) note that there has been some debate about the level of alpha values deemed acceptable when considering the internal consistency of a measure for research purposes. Alpha values are affected not only by reliability, but also the number of items in a scale and the presence of multidimensionality. In such instances a Cronbach alpha level of 0.50 may be deemed acceptable. Additionally, an alpha level of 0.50 is considered to be acceptable for a research instrument used for group comparisons, rather than for an instrument used to make important academic decisions (Watkins, 1998). Kember et al. (2004) argue that the two main scales of the R-LPQ-2F can be interpreted as reliable as alpha values exceed 0.70. All of the approaches, subscales and subcomponents, with the exception of relating ideas, have Cronbach alpha values above 0.50 even though the subscales exhibit multidimensionality and some subcomponents have only two items (see Table 3.4).

Table 3.3

The Hierarchical Nature of the R-LPQ-2F

Construct	Subscale	Subcomponent	Questions on R-LPQ-2F
Surface approach	Motive	Fear of failure	3,7
		Aim for qualification	11,15
	Strategy	Minimising scope of study	4,8,12,16
		Memorisation	18,20,22
Deep approach	Motive	Intrinsic interest	1,5,9
		Commitment to work	13,17,19,21
	Strategy	Relating ideas	2,6
		Understanding	10,14

(Kember, Biggs, & Leung, 2004)

Table 3.4

Reliability Data for the R-LPQ-2F Scale Score

Construct	α value[a]	Subscale	α value[a]	Subcomponent	α value[a]
Surface	0.71 (11 items)	Motive	0.58 (4 items)	Fear of failure	0.65 (2 items)
				Aim for qualification	0.63 (2 items)
		Strategy	0.68 (7 items)	Minimising scope of study	0.52(4 items)
				Memorisation	0.55(3 items)
Deep	0.82 (11 items)	Motive	0.75 (7 items)	Intrinsic interest	0.59(3 items)
				Commitment to work	0.70(4 items)
		Strategy	0.66 (4 items)	Relating ideas	0.48(2 items)
				Understanding	0.59(2 items)

[a]Published data based on 841 students (Kember, Biggs, & Leung, 2004).

Combined learning process questionnaire

Although no norms are available for the R-LPQ-2F to assist categorisation of a student's learning approach, it provides more detailed information than the LPQ due to the subcomponent dimensions. This additional information was deemed valuable for the integration of quantitative and qualitative data sets during case study at the analysis phase. The R-LPQ-2F provides no information on the achieving approach, consequently to overcome what is considered a limitation of the survey instrument (Watters & Watters, 2007), the Researcher produced a composite survey, the Combined Learning Process Questionnaire (cLPQ), which combined the R-LPQ-2F with the achieving approach scale of the original LPQ. The cLPQ measure was used for additional learning approach surveys of Year 9 students in the G&T class of the GTSP in 2007.

The cLPQ is a 34 item self-report questionnaire that provides information on three basic motives for learning and three learning strategies that together form three approaches to learning: surface, achieving and deep (see Appendix C for the cLPQ questionnaire and answer sheet). There are six subscales on the cLPQ: surface motive (SM), deep motive (DM), achieving motive (AM), surface strategy (SS), deep strategy (DS) and achieving strategy (AS). Each of the surface and deep subscales are further divided into subcomponents as in the R-LPQ-2F measure (see Table 3.3). The distribution and number of questions for each scale on the cLPQ is shown in Table 3.5.

Table 3.5

Question Distribution on the cLPQ

Construct	Subscale	Subcomponent	Questions on cLPQ
Surface approach (11 items)	Motive	Fear of failure	7, 19
		Aim for qualification	1, 13
	Strategy	Minimising scope of study	4, 22, 25, 32
		Memorisation	10, 16, 27
Deep approach (11 items)	Motive	Intrinsic interest	2, 14, 20
		Commitment to work	8, 17, 30, 33
	Strategy	Relating ideas	5, 23
		Understanding	11, 28
Achieving approach (12 items)	Motive	Achievement	3, 9, 15, 21, 26, 31
	Strategy	Effective use of space and time	6, 12, 18, 24, 29, 34

On the cLPQ respondents rate themselves using a five point scale, from 5 ‘this item is always or almost always true of me’ to 1 ‘this item is never or only rarely true of me’. All items are scored in the same direction.

In order to address Research Questions 2 and 4, an LPQ measure (LPQ or cLPQ) was administered to determine the learning approach profile of GTSP students. The G&T and ALP classes were surveyed twice in Year 8 2006 (LPQ Term 1 and Term 3) and once in Year 9 2007 (LPQ Term 4), in addition the Year 9 G&T class was also surveyed twice in 2007 (cLPQ Term 1 and Term 3). However, it has been suggested that in evaluation of teaching effectiveness the LPQ should be used as one element in a package not the sole indicator (Watkins, 1998), therefore qualitative data were also used to further examine the learning approach of Year 9 G&T students.

Classroom Environment Measures

The nature of the science classroom environment was studied by using an instrument, the Individualised Classroom Environment Questionnaire (ICEQ) (Fraser, 1990). The instrument is a tool for monitoring perceptions of aspects of individualisation of the curriculum and measures five dimensions: *Personalisation, Participation, Independence, Investigation* and *Differentiation*.

This research used student perception measures due to the following attributes (Fraser, 1990). Questionnaires are more economical than ethnographic observation. Perceptual measures are based on collective information built up by multiple students over an extended period as opposed to observational data that is generally a synopsis of a few observations by an individual. Students’ perceptions of their classroom environments determine student outcomes not observers’ perceptions. The perception of the GTSP students of their classroom environment is an important analytical tool to determine if their needs are being met.

Individualised classroom environment questionnaire

The Individualised Classroom Environment Questionnaire (ICEQ) Long Form has 50 items, 10 for each dimension and is traditionally responded to using a five point Likert scale with alternatives: almost never, seldom, sometimes, often and very often. Scoring direction is reversed on many items. Fraser reports that the ICEQ has ". . . adequate internal consistency reliability and discriminant validity for use with students or teachers, in its actual or preferred form, and using either the individual student or the class mean as the unit of analysis" (Fraser, 1994, p. 501). The internal consistency reliability is an estimate of how consistent the performance on the different items within a given scale is. The discriminant validity estimates how well the five distinct conceptual scales are working independently (see Appendix D). The ICEQ is also a relevant tool to use for monitoring changes over time in a class following curriculum innovation (Fraser, 1990).

Revised individualised classroom environment questionnaire

The Researcher made amendments to the ICEQ prior to the research commencing. Amendments were made on the basis of: internal consistency data from analysis of the pilot study carried out in 2005 (see Table 3.6), the Researcher's tacit knowledge of GTSP classrooms and anecdotal information collected in verbal and written form during the pilot study in 2005. The revised measure was named the Revised Individualised Classroom Environment Questionnaire rICEQ. Two versions of the rICEQ were used one to measure preferred classroom environment and one to survey perceptions of actual classroom environment, the versions differed only in subtle changes to wording of questions (see Appendix E for the preferred rICEQ questionnaire and answer sheets).

Considerable changes were made to the *Independence* dimension ($\alpha = 0.47$) as it appeared that many items on the original ICEQ measure addressed discipline issues rather than student autonomy in relation to learning tasks. The items on the *Differentiation* dimension ($\alpha = 0.25$) were reworded to reflect the context of outcomes based education and the use of specific resources in GTSP classrooms. Questions on the

Investigation dimension (α = 0.69) were reworded for clarity. For this research the rICEQ questionnaire was modified to a four point scale, almost always, often, sometimes, almost never to improve discrimination between positive and negative perceptions (Assor & Conell, 1992). Further analysis of internal consistency, using data from the rICEQ pretest, indicate that the changes made to the survey instrument had improved the Cronbach alpha levels of the *Independence* dimension (α = 0.66), the *Differentiation* dimension (α = 0.63) and the *Investigation* dimension (α = 0.80) (see Table 3.6.).

Table 3.6

Reliability Data for the ICEQ and rICEQ Scale Score

	Internal consistency (alpha coefficients) Individual unit of analysis			
Construct	Preferred[a]	Actual[b]	Pilot[c] (actual)	Pretest[d] rICEQ (preferred)
Personalisation	0.79	0.74	0.83	0.67
Participation	0.70	0.67	0.69	0.49
Independence	0.68	0.70	0.47	0.66
Investigation	0.71	0.75	0.69	0.80
Differentiation	0.76	0.75	0.25	0.63

[a]Preferred based on 1849 students (Fraser, 1990, p. 14).
[b]Actual based on 1858 students (Fraser, 1990, p. 14).
[c]Pilot based on 26 students 2005
[d]Pre-test based on 66 students 2005

The revised instrument rICEQ was used to collect data relating to Research Questions 1 and 4 concerning the preferred science classroom environment and actual environment. It was administered to consenting students and teachers of the GTSP classes. Averages of the scores of class members were analysed (consensual press) as such averages are considered more reliable (Fraser, 1990). The preferred classroom environment was assessed at the beginning of the research study (beginning of Year 8 2006), after a semester (beginning of Semester 2 Year 8 2006) and again at the end of the academic year 2007 (close of Year 9 2007). Analysis of the actual classroom environment was undertaken using the appropriate format of the rICEQ in Semester 2 Year 8 2006 when the students had been taught for a semester so they could make a reliable, on balance judgment concerning the nature of their science learning environment within the GTSP with respect to the five dimensions of the measure. The G&T and ALP science teachers 2006 also completed the surveys for comparative purposes. Gunstone (1995) notes that ideas about teaching and learning roles are learnt, so it is possible that the teachers' and students' perceptions about their preferred classroom environment changed as a result of the milieu that existed in the GTSP. It was with this in mind the preferred classroom environment was surveyed multiple times during the research period to address Research Question 1. The interrelationships between the learning environment and other factors are explored in Research Question 4.

Self-Efficacy Measure

Self-efficacy of learning is defined as a sense of confidence regarding the performance of particular tasks (Bandura, 1997; Jinks & Morgan, 1999). To assess students' perceptions of their self-efficacy, one dimension from the Student Attitude and Efficacy Scales was used. This measure was developed for use with the Technology Rich Outcomes Focused Learning Environments (TROFLE) developed by Aldridge, Fraser and Fisher (2003). The Academic Efficacy scale in particular was modified from the Morgan-Jinks Student Efficacy Scale (MJSES) developed by Jinks and Morgan (1999) (see Appendix F). All items were designed for Likert-scale responses, using a four interval scale from 1 agree, to 4 disagree. Published data on the reliability of the Student Attitude and Efficacy Scales indicated that the internal consistency was strong $\alpha = 0.81\text{-}0.87$ using the individual as the unit of analysis (Aldridge, Fraser, & Fisher, 2003, p. 172). Data analysis of the pretest showed that the internal consistency of the self-efficacy scale used in this research was $\alpha = 0.83$. The MJSES and the modified scale of Aldridge et al. (2003) are useful in the evaluation of educational interventions (Jinks & Morgan, 1999). The self-efficacy measure (see Appendix F) was administered to the G&T and ALP classes at the beginning of Year 8 (2006), after a semester in the GTSP (Year 8 Semester 2 2006) and at the end of the Year 9 (2007). The self-efficacy measure was administered at the same time as the rICEQ preferred environment measure to streamline the survey process.

Limitations of Surveys

Quantitative methods are used to examine patterns and trends across a sample to see if what is true for an individual applies on a larger scale. However, to rely solely on data from surveys would have ignored the various limitations of this form of quantitative technique which follow. The range of questions on a measure may not represent the range of cues in the environment relating to a particular dimension. In answering a question as to whether classroom discussion occurs for example it may be difficult to determine the frequency of its use, or more particularly, the ways that the discussion may have been beneficial. Survey structure makes it difficult to determine the process through which students construct meaning out of various instructional practices in the classroom. Also the survey data was aggregated prior to analysis so individual perceptions were lost. Classrooms are dynamic and practices may be viewed differently at different times of the year (Urdan, Kneisel, & Mason, 1999).

Qualitative Research Methods

Since individuals differ in their perceptions and interpret the same classroom activity in different ways, qualitative methods were incorporated into the research to triangulate data for each research question (Urdan et al., 1999). Qualitative data included: transcripts of video of focus group interviews, transcripts from one-on-one interviews, field notes from classroom observations and associated artefacts (Patton, 2002) (see Table 3.1).

Focus Groups

A contemporary focus group interview involves six to 12 individuals discussing a particular topic facilitated by a moderator to promote interaction and ensure the discussion remains on topic (Kitzinger & Barbour, 1999; Stewart & Shamdasani, 1990). Interactions between the participants enhance the quality of data as the participants tend to provide data checks and balances on each other which act to weed out extreme views. However since those with a minority view may not speak up, a focus group works best when the participants do not know each other as the group dynamics are different. Focus group interviews are good for identification of major themes (Patton, 2002).

Having analysed the first round of Year 8 LPQ survey data (2006), purposive sampling (L. Cohen, Manion, & Morrison, 2000) was used to select three focus groups. Each focus group was made up of students with a particular learning approach so that the sample (n = 21) matched the research objectives: Group 1- deep approach (n = 3) or deep/achieving approach (n = 5); Group 2- achieving approach (n = 5) and Group 3- surface approach (n = 8).

This type of sampling is called theory based or operational construct sampling (Mertens, 2005) as the theoretical construct of learning approach had been operationalised and sample selection focused on individuals who theoretically exemplified particular learning approaches. The consent rate for the focus group interviews was 84%. The consenting students (n=21) represented 32% of the total students surveyed by LPQ (2006) (n=66), a representative sample for the purpose of triangulation. Participation rate for the focus group interviews was 100% of those selected who had consented. The size of each group allowed discussion without becoming unwieldy. The focus groups were interviewed at the beginning of Semester 2 2006 using clear ground rules to ensure the discussion remained focused. The duration of each of the three focus group interviews was an hour. The focus groups were videotaped for data recording purposes and fully transcribed. The camera was mounted so as to be non-intrusive, but to enable capture of the dialogue of the individual participants and their interactions. Interviews took place in a small meeting room around a large oval table. The Researcher dressed as for teaching in school, so that the students were not intimidated or given any indication that the interview process was a form of evaluation for them or the Researcher (Stewart & Shamdasani, 1990).

In order to address Research Questions 1, 2, 3 and 4, the moderator, who was also the Researcher, took a fairly directive and structured approach that assisted her to: focus the interactions whilst allowing individual experiences and perspectives to emerge (Patton, 2002); close in on the research questions following the broad information provided by the questionnaires; supplement information provided in the questionnaires for triangulation purposes by collecting qualitative data expressed in the respondents' own words and context (confirmatory application) (Stewart & Shamdasani, 1990); and ascertain whether the methods of assessment used and the nature of feedback contribute to confusion over the goal orientation in the classroom (exploratory application) (Stewart & Shamdasani, 1990). The questions used for the focus interviews are given in Appendix G.

Classroom Observations and Collection of Artefacts

In order to immerse herself and acquire data about the processes that have an impact on the students' learning approach and self-regulated learning (SRL) strategies, the Researcher observed students in the Year 9 G&T class in the context of their science classroom, over a period of a school term (Term 1, 2007), working individually, in dyads and small groups as the situations presented themselves. A total of 14 classes were observed with each lesson an hour in length.

Prior to classroom observation, information letters had been provided to students and parents/guardians, thus the purpose of the research was known. The consent rate for students in the G&T class was 100%. The first occasion of classroom observation occurred during the first G&T Year 9 science class for the year (2007). The classroom teacher introduced the Researcher at the commencement of the class and explained the purpose of the research. The Researcher was known to most of the students as many of them had been involved in the research as Year 8 students.

During each period of observation, the Researcher sat at the back of the class in an unobtrusive position for the start of the lesson. When classroom activities commenced, the Researcher moved around the room, assisting and talking with the students and their teacher as appropriate. The Researcher assumed the role of a knowledgeable teacher's aide. The science content of the lessons was familiar to the Researcher as she was an experienced GTSP science teacher herself. The personal tacit knowledge of the Researcher provided an auxiliary source of data that enriched the collected data. Whilst this knowledge was not formally measured it provided informal data that guided observations and analysis (Tashakkori & Teddlie, 1998). The Researcher and G&T class teacher had collaborated in the development of the GTSP curriculum and shared common educational philosophies. Thus the Researcher enjoyed a good working relationship with the teacher of the G&T class that had been developed over a number of years.

Since the Researcher took part in the activities she was observing, this was participant observation (Cohen et al., 2000). The Researcher took the stance of an observer as participant. The Researcher's purpose as an observer was known to the group and these observations took precedence over participation in the activities of the group (Merriam, 1998). Data collection was by field note taking. Classroom events, and personal reactions to these, were noted separately so that distinctions could be made between observations and opinion (Bouma & Ling, 2004). Notes were made as soon after observations as was feasible. Artefacts, in the form of student work samples, that related to the activities observed were collected. Additional artefacts were sourced from the students' portfolios that spanned the whole of Year 9 and included assessment items as well as class work (Appendix H).

Recruitment of Students for One-on-One Interviews

The first step for conducting one-on-one interviews was to select a suitable sample, using operational construct sampling (Mertens, 2005), which meant having representatives from each learning approach. Firstly, LPQ scores from Year 8 2006 were used to assist purposeful criterion sampling of students with predetermined criterion characteristics, particular learning approaches, for in-depth qualitative analysis (Patton, 2002).

In order to select a suitable sample for interview, the Researcher looked initially at each student's LPQ data from the end of 2006 in turn. Table 3.7 shows the relationship between students' LPQ scores and deciles reported in the literature (Biggs, 1987b). The connection between a student's score and published deciles is dependent on age and gender. The maximum score possible in each dimension of the LPQ is 60. For example, by referring to Table 3.7, one can see that for a girl aged 14 years a score above 44 in any dimension of the LPQ would place them above the eighth decile for that dimension (Biggs, 1987b). A score in the eighth decile or above indicates that a student has a positive predisposition to that particular learning approach. In relation to a predisposition to a deep/achieving approach, a combined score in excess of 82 for a female or 83 for a male from the deep and achieving dimensions would place the student's score above the eighth decile (Biggs, 1987b). Using codes for positive disposition (+), neutral disposition (0) and negative disposition (-) a predisposition profile was assigned to each student on the basis of their LPQ scores from the end of 2006.

Table 3.7

Assigning a Learning Approach to Students at Age 14 Years

		Surface		Deep		Achieving	
		Motive	Strategy	Motive	Strategy	Motive	Strategy
Girls	Greater than decile 8 Code +	24	20	22	22	23	21
	Decile 4-7 Code 0	34- 43		34-43		33-43	
	Less than decile 3 Code -	19	14	17	14	17	15
Boys	Greater than decile 8 Code +	24	21	22	20	24	20
	Decile 4-7 Code 0	36-44		32-41		33-43	
	Less than decile 3 Code -	19	16	17	14	18	14

(Biggs, 1987b)

A summary of the predisposition profiles used in the literature to classify students with specific learning approach profiles is provided in Table 3.8 (Biggs, 1987b). For example a female scoring 26 on surface motive and 21 on surface strategy would have a combined surface approach score of 47 which would indicate a predisposition towards a surface approach. Such a student would be assigned a code of

(+ +) for the surface dimension (see Table 3.7). The same student might have a composite deep approach score of 29 (motive 17, strategy 12) indicating a negative predisposition to deep learning with a code (- -). A student with a predisposition profile (+ +, - -, - -) has a positive predisposition towards a surface approach and negative predispositions to both deep and achieving approaches (see Table 3.8). According to Biggs (1987b) such a student would be classified a surface exclusive learner. Where the predisposition profiles of students allowed a classification process, analysis of LPQ scores at the end of 2006 were used to assign students a specific learning approach classification.

Table 3.8

Specific Learning Approach Profiles

Learning approach classification	Surface motive	Surface strategy	Deep motive	Deep strategy	Achieving motive	Achieving strategy
Surface predominant	+	+	0	0	0	0
Surface exclusive	+	+	-	-	-	-
Deep predominant	0	0	+	+	0	0
Deep exclusive	-	-	+	+	-	-
Achieving predominant	0	0	0	0	+	+
Achieving exclusive	-	-	-	-	+	+
Deep achieving	0	0	+	+	+	+
Deep achieving	-	-	+	+	+	+
Surface achieving	+	+	0	0	+	-
Low achieving	0	0	0	0	-	0
Low achieving	+	0	0	0	-	0

(Biggs, 1987b)

The results from cLPQ surveys were also used to assist purposeful criterion sampling. A cLPQ was administered just prior to one-on-one interviews in the fourth week of the academic year (2007) to Year 9 G&T science students (n=28) (response rate 100%). Total scores on the deep, achieving and surface dimensions assisted classification of students.

Consent rate for the one-on-one interviews was 79%. The students interviewed represented 19% of the students surveyed in Year 9 2007 and 39% of the Year 9 G&T class. At the time of interview selected students were assessed as having the following profiles deep approach (n=1), deep/achieving approach (n= 2), achieving approach (n=

4), surface approach (n= 3). One student was specified as a low achiever according to classification data (see Table 3.8).

One-on-One Interviews

The purpose of the one-on-one interviews was to investigate how assessment tasks impacted on the use of self-regulated learning (SRL) strategies by Year 9 G&T students with different learning approaches. Interview guides were used to structure the interviews. The interviewer, who was the Researcher, tried to build rapport with the student being interviewed whilst maintaining neutrality with respect to the content of what the student said (Patton, 2002). The interviewer was known to each student as a result of the period of participant observation that preceded the interviews.

The first interview, Interview A, commenced with an open-ended question regarding the student's preparation for a recently completed common assessment task (CAT). The focus was on the student's use of SRL strategies. A semi-structured interview schedule was used to further probe the student's use of SRL strategies, in particular their use of cognitive organisers in their preparation for the CAT (see Appendix I). The effectiveness of various cognitive organisers presented in class was also discussed in relation to student preparation for, and successful completion of, the assessment task. Data obtained during classroom observations by the Researcher were used to prompt student recall.

Protocol Analysis

The aim of a think aloud protocol (Patton, 2002) is for the interviewer to ask questions that bring to consciousness the inner thoughts of the student as they perform a task. It is a concurrent approach as the student is thinking aloud whilst actively engaged with a task, rather than reasoning retrospectively at the conclusion of a task. This type of protocol is considered more reliable as it does not depend on the subject's short term memory recall of the strategies they think were engaged whilst doing the task (Patton, 2002). Analysis of data from think aloud protocol depends on understanding the human information processing model “The information that is heeded during the performance of a task, is the information that is reportable: and the information that is reported is the information that is heeded” (Anders Ericsson & Simon, 1993, p. 163).

During the second interview, Interview B, each sample student was presented with a hypothetical assessment task. The task was designed to be analogous to an open-ended, authentic, assessment task such as are used in the GTSP (see Appendix J). The students were encouraged to ‘think aloud’ (Anders Ericsson & Simon, 1993) and outline the planning processes they would adopt to accomplish the hypothetical task. Students were invited to draft and discuss the format of the written information they would present to their target audience as one component of the task. In preparation for the one-on-one interviews the Researcher used her pedagogical content knowledge, and field notes from the participant observations, to preselect several common cognitive organisers aligned to the organisation and transformation of information processes required for the successful completion of the task. Black-line masters of a SWOT analysis (strengths, weaknesses, opportunities, threats), a balance, a PCQ (pros, cons, questions) and a fishbone were tabled at each one-on-one interview and the student interviewed was encouraged to discuss their familiarity with each organiser and how effective it might be in the planning phase of the hypothetical task. Although the Researcher had not seen all of these organisers used in G&T science classes during participant observation, the chosen organisers had been modelled to MHS staff at professional development sessions and thus the Researcher thought it likely that the students would have had experience of all of them.

All one-on-one interviews lasted approximately 30 minutes. Each interview was tape-recorded and subsequently transcribed. Data were reviewed and analysed to find common themes to describe and explain the use SRL strategies under various task conditions. This process was informed by Zimmerman’s 14 categories of SRL strategy. Cross-case analysis involved examination of themes, from multiple data sources, in relation to self-regulated learning and the learning approaches of the students interviewed, namely deep, achieving, deep/achieving or surface learning approaches.

Data Analysis

Quantitative Data: Data Cleaning

After each phase of survey, LPQ, ICEQ and self-efficacy measure, the student questionnaires were examined for missing data. In instances where a whole self-efficacy survey had not been completed (as it was presented with the ICEQ but on the reverse side) the survey was returned to the student for completion preferably during the next science lesson. Contextual problems that had become apparent during the pilot study which resulted in students finding certain items difficult to respond to had been altered. Individual items on the LPQ that were missed were scored as 3 (true of me about half the time) in each case. Individual items on the ICEQ and self-efficacy measure that were missed were scored as 2 (sometimes) in each case. A number of items on the ICEQ were negatively scored so these were recoded to a positive score, for example a score of four became a score of one and so on. In total 16 items on the ICEQ were recoded in this way. For the ICEQ and LPQ, scores for each dimension of the survey were totalled prior to data entry.

Quantitative Data: Data Screening

All students completed the questionnaires fully and reliably. Reliability in questionnaire completion was determined by the absence of obvious patterns in the student questionnaires, for example answering Question 1 with a score of 1, Question 2 with a score of 2 etc. As discussed previously, the self-efficacy measure was administered with the ICEQ. On occasions when the Researcher found self-fffficacy measures not completed, she was able to reschedule the student to complete the survey. This took place within the same week as the initial survey.

Total scores for each of the dimensions of learning approach and classroom environment were first recorded in the individual student questionnaires. Computations were repeated to ensure accuracy. Scores for each student were recorded onto an Excel spreadsheet. The data set for each student also included their name and class. As each questionnaire was completed through the research period data were added to each student's profile. Scores for each measure were then recorded onto two SPSS files, one for each GTSP class, G&T and ALP (Coakes, 2005). At the end of 2007, when students had completed Year 9, two further SPSS files were created. Each of these SPSS files contained a complete set of data for those students in the G&T and ALP classes of the GTSP in Year 9 2007 who had remained in the same class for the whole research period. Only the data from students who had remained in the same class, G&T or ALP for the whole research period and for whom a complete data set was available because of consent to take part in the study in Year 8 followed by Year 9 was used in the analysis.

All quantitative data were subjected to statistical analysis using a software package SPSS to determine the significance of the findings. Table 3.9 indicates the independent and dependent variables for each data set, the nature of the variables and the type of statistical test undertaken. Where statistical significance of quantitative findings was evident, effect sizes were calculated and reported.

Table 3.9

Statistical Tests

Research Question	Independent variable	Nature of variable	Dependent variable	Nature of variable	Test
1	GTSP Class	Categorical (binary)	HAST	Continuous	Independent *t* test
1	GTSP Class	Categorical (binary)	Preferred classroom environment	Interval	Independent *t* test
1	GTSP Class	Categorical (binary)	Actual classroom environment	Interval	Independent *t* test
1	GTSP Class	Categorical (binary)	Change in preferred classroom environment	Interval	Paired *t* test
2	GTSP Class	Categorical (binary)	Learning approach	Interval	Independent *t* test
2	GTSP Class	Categorical (binary)	Change in learning approach	Interval	Paired *t* test
2	GTSP Class	Categorical (binary)	Self-efficacy	Interval	Independent *t* test

Qualitative Data

In relation to validity of qualitative inquiry, Patton (2002, p. 246) states “What is crucial is that the sampling procedures and decisions be fully described, explained and justified so that information users and peer reviewers have the appropriate context for judging the sample”.

In a multiple case study there are two stages of analysis: within case and across-case (Merriam, 1998). Since this was a nested design, initially the Researcher attempted to build a general explanation about students with a particular learning approach from the individual subordinate cases and subsequently used this information to build a picture about the super-ordinate GTSP case. Constant comparative methods were used to construct categories from the data. Each category was a conceptual element that subsumed many individual examples. In relation to coding, Patton (2002) describes internal homogeneity as the extent to which data that belong to a certain category hold together in a meaningful way and external heterogeneity as the extent to which different categories are bold and clear. The final set of categories was both relatively exhaustive, given that data collected was the result of responses to a fairly structured interview protocol, and mutually exclusive. Further detail of the analysis of the interviews conducted follows.

Focus Group Interview Analysis

The videos of the three focus group interviews conducted at the beginning of Semester 2 2006 with Year 8 students were viewed several times and then transcribed. The Researcher reviewed the videos several times more to check the transcriptions for accuracy and immerse herself in the emerging themes. The questions asked using the interview protocol were copied and transferred to three large pieces of paper, one for each focus group, and the answers to each question placed underneath with a code to distinguish the specific student who had made the response and their learning approach. For example FA5 denoted student 5 who had an achieving approach. In this way answers that were repeated both within groups and across groups would be apparent. This process allowed the identification of themes in relation to specific questions.

Common elements were grouped together for clarity. Specific quotes were identified that were pertinent for inclusion in the thesis as they added weight to the themes. Analysis of themes within groups and across groups followed. This involved identifying common ideas expressed multiple times within a group and noting how many of the focus groups mentioned the same idea, across groups. The Researcher was thus able to generate findings in relation to the qualitative data collected from focus groups particularly in regard to assessment practices, self-efficacy and self-regulated learning (Research Questions 1 and 2). Focus group data was also valuable in the support of data collected by other means as a way of triangulating to increase internal validity. Triangulation of data was achieved in relation to classroom environment (Research Question 1). A schematic representation of the data sources used in the generation of key findings as evidence of triangulation is shown in Figure 3.2.

One-on-One Interview Analysis

Analysis of one-on-one interviews followed a similar process to that used for the focus group interviews. The Researcher conducted 22 interviews in total in Term 1 2007 with Year 9 GTSP students with specific learning approaches. Eleven of these were Interview As and 11 Interview Bs. Following each one-on-one interview, the audio tape was listened to several times by the Researcher and then transcribed. The tape was played back and the transcribed notes checked for accuracy. Each student's answers were given a code so that the source could be identified to assist the analysis phase. The process was repeated for each of the 11 interviews of type A. On completion of the transcription process, the students' responses to each question of the interview protocol were grouped. As a result of this grouping keywords and themes were identified guided by Zimmerman's 14 categories of SRL strategy. To assist within group and between group analyses the Researcher grouped similarities and differences in themes emerging from Interview A in relation to the students' learning approaches. After analysis specific quotes in relation to major themes were identified from the transcribed interviews. The findings from Interview A provided a means to view self-regulated learning in the context of the MHS common assessment tasks in science (Research Question 2). Data from Interview A also added to the data from participant observation and LPQ survey in particular in the way students with different learning approaches engaged in their studies and their feelings of self-efficacy (Research Question 2) (see Figure 3.2).

The process of analysis of data described previously for Interview A was repeated with the data from Interview B. Data from Interview B allowed the generation of findings concerning the use of self-regulatory learning strategies in the context of authentic tasks. It also allowed an in depth perspective on the autonomous use of cognitive organisers by students in the GTSP (Research Question 2). Data from Interview B enriched the data from LPQ survey with respect to the way students with different learning approaches engaged in assessment tasks (Research Question 3) (see Figure 3.2).

Research Ethics

Prior to the commencement of research, appropriate ethics clearance was obtained through the Edith Cowan University Research Ethics Committee. A letter was sent to the Principal of MHS (a pseudonym) to outline the research and gain his consent for the study. Information letters were then sent to all selected Year 8 students and their parents/guardian. At this point parents and students had the right to consent or decline participation in the research, they were also informed of their right to withdraw consent at any stage. As the students involved in the study were to complete named questionnaires, their consent to participate was obtained and that of their parents/guardian. Although all surveys were named, the data from individual surveys have not been reported in this research except for the four students selected for case study. Pseudonyms were used for the case studies to refer to the participating students throughout the relevant sections of the thesis. The aim was to protect the identity of any participants both within this thesis and any additional articles connected to this research. Additional consent forms were obtained for Year 8 students participating in the focus group interviews. Only transcripts from video footage were used for the purpose of this research and participants in the focus group interviews were thus informed. Within the thesis pseudonyms have been used for all participants in the focus group interviews.

The process to gain consent for participating in surveys was repeated at the start of Year 9 for GTSP students, with additional consent forms obtained for students participating in one-on-one interviews. Participants were informed of their right to withdraw at any stage. The anonymity of students participating in one-on-one interviews was attended to by using pseudonyms in relevant chapters of the thesis. Samples of information letters and consent forms are included in Appendix K.

The Researcher was a teacher in the GTSP, but to avoid bias she chose not to teach the classes under investigation during the period of data collection. As an experienced teacher of the GTSP at MHS, the Researcher was known to the students in the Year 9 G&T and ALP classes. In all interactions with the students, the Researcher tried to build rapport, whilst maintaining neutrality with respect to the content of any conversations (Patton, 2002). The Researcher was completely open when asked by individuals about the reason for conducting surveys, participant observation or interviews. The participant observation phase of this research in particular required the Researcher to be sensitive to the impact of her presence in classes.

Providing an Audit Trail for the Emergence of Conclusions

The purpose of Figure 3.2 is to provide a structure that allows the reader to follow the research process from the framing of research questions through to the drawing of conclusions. In this research there were four main themes embodied in the research questions namely the nature of the Gifted and Talented Science Program; students and learning; student achievement, and factors that affect achievement. Each theme is the subject of a chapter of this thesis.

A wide range of data was collected, both quantitative and qualitative, in an effort to answer these questions in a robust fashion. The nature and classification of the types of data sources is presented in Figure 3.2. Analysis of all the data collected resulted in the development of key findings. To provide a visible audit trail, the types of data sources that resulted in the development of each of the key findings are shown in Figure 3.2.

Once findings had been interpreted, the Researcher looked to interrelationships between them to draw up general assertions under each of the four themes that specifically addressed the research questions. The aggregations of findings that can be attributed to the development of each general assertion are delineated in Figure 3.2.

It is hoped that Figure 3.2 thus provides a clear picture of the process underpinning the emergence of conclusions for this research study. To enhance internal validity, how well the research findings match reality, the Researcher used the following strategies (Merriam, 1998): triangulation of data (see Table 3.1. and Figure 3.2); member checks with the teacher of the class being observed, longitudinal study over the research period of two years, participant observation over one school term, the Researcher was a GTSP teacher; and the Researcher's biases were clarified at the outset of the study.

The following chapters present the research findings for both the quantitative and qualitative research. A discussion chapter then focuses on the interpretation of these findings. The results of the quantitative and qualitative research are integrated at this point to provide triangulation of data and increase the internal validity of the research.

Themes	The nature of the Gifted and Talented Science Program	Students and learning	Student achievement	Factors that affect achievement
General assertions	**9.1**: KFs: 4.1; 4.2: 4.7; 8.1 **9.2**; KFs: 4.3; 4.4; 4.5; 4.6	**9.3**: KFs: 5.1; 8.1; 8.2; 8.3; 8.4 **9.4**: KFs: 4.3; 5.2; 5.3 **9.5**: KFs: 5.2; 5.3; 5.4 **9.6**: KF: 5.5	**9.7**: KFs: 6.1; 6.2; 6.3; 6.4; 8.1; 8.4 **9.8**: KFs: 4.2; 4.3; 4.6; 5.3; 5.4; 6.5; 8.2; 8.3; 8.4	**9.9** : KFs: 5.1; 6.1; 6.5; 7.1 **9.10**: KFs: 7.2; 7.3 **9.11**: KFs: 7.4; 7.5 **9.12**: KFs: 8.1; 8.2; 8.3; 8.4

Key findings	4.1	4.2	4.3	4.4	4.5	4.6	4.7	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	7.1	7.2	7.3	7.4	7.5	8.1	8.2	8.3	8.4
	D	O I A	S I	T	S	S I	S	S	O I A	I	I	S I	D	D	D	D	I A D	S D	D	D	S D	S D	S T O I A D	S I A D	S I A D	S O I A D

Data sources	Student questionnaires (S)	Teacher questionnaires (T)	Field notes (O)	Student interview (I)	Artefacts (A)	Achievement data (D)
	ICEQ Preferred Actual Satisfaction survey LPQ / c LPQ Self-efficacy	ICEQ Preferred Actual	Participant observation	Focus group interviews Interview A Interview B	Portfolio	HAST MHS: CATs, Examinations MSE: Science Mathematics ICAS National chemistry quiz Australian maths competition

Figure 3.2. Schematic representation of the association between the data sources, findings, general assertions and the themes of the research.

CHAPTER 4

THE NATURE OF THE TEACHING AND LEARNING CONTEXT WITHIN THE GIFTED AND TALENTED SCIENCE PROGRAM

This chapter provides a range of data that gives insight into the nature of teaching and learning within the Gifted and Talented Science Program (GTSP) at Metropolitan High school (MHS), the focus of Research Question 1. The chapter is organised into five sections as follows: Higher Ability Selection Test used for selection into the GTSP; science curriculum at MHS; teaching practices within the GTSP including learning tasks and assessment tasks; student perceptions of the classroom environment: preferred and actual; teacher perceptions of the classroom environment: preferred and actual; and student perceptions of their satisfaction with their classroom teacher.

Higher Ability Selection Test

The nature of the teaching and learning environment within the GTSP is dependent to some extent by the participants in the program. This section describes how students enter the GTSP at MHS. Students are selected for the GTSP using results from the Higher Ability Selection Test (HAST). The HAST is administered by the Australian Council for Educational Research (ACER) when children are in Year 7 (12 years old). In particular the students' results on the mathematics component of the HAST, which incorporates elements of problem solving, is used as an indicator of possible science aptitude. Where the mathematics score of a child is slightly below the cut-off for selection into the GTSP, a high score on the reading comprehension component may confer entry.

In June 2005, a total of 146 students sat the HAST to gain admission into the Year 8 GTSP in 2006 at MHS. The students' total standardised scores ranged from 76-219. The students' standardised scores in mathematics ranged from 28-70. ACER does not provide data about the total score possible in each section of the test, although percentile data are made available.

In order to gain entry into the Gifted and Talented (G&T) class of the GTSP in 2006, a standardised mathematics score greater than 58 was required, with the student placed in the 6^{th} stanine or above on the basis of their total standardised score (i.e. 158 and above). At the start of 2006 when the students were in Year 8, there were 26 students in the G&T class of the GTSP, of whom 21 consented to participate in this research.

Students who did not qualify for the G&T class in 2006 were able to gain entry into the Accelerated Learning Program (ALP) class of the GTSP, with a standardised mathematics score greater than 51, with the student placed in the 5^{th} stanine or above on the basis of their total standardised score (i.e. 152 and above). One student gained entry to the ALP class on the basis of alternative test data supplied to the school. At the beginning of 2006 there were 26 students in the Year 8 ALP class of the GTSP, of whom 17 consented to participate in this research. The table below (Table 4.1) shows the difference in the HAST standardised mathematics scores for the two classes. The data show that there was a significant difference in the mean mathematics scores of the two selected classes $t\ (35) = 2.127,\ p < .05$.

Table 4.1

Standardised Mathematics Scores for the G&T and ALP Classes

Class	N	HAST Maths Mean	Std. Deviation	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
G&T	21	60.76	7.790	1.700	2.127	35	0.041*
ALP	16	56.50	2.033	0.508			

Note * $p < .05$

Finding 4.1

Students in the GTSP G&T and ALP classes were selected on the basis of their HAST mathematics scores which were used as an indicator of their aptitude for science. There was a significant difference in HAST scores between these two classes, but students in each class were likely to be more closely matched in aptitude for science than if they had entered normal heterogeneous mainstream science classes at MHS for which no such selection process occurs. This homogeneity was likely to improve the academic learning that occurs from social interactions between like peers in classrooms.

Science Curriculum at MHS

Students in the Year 8 and Year 9 GTSP followed the same general science curriculum as all other students at MHS (see Appendix L) with compaction and differentiation of content and approach. Each year, content from four conceptual strands was covered to provide students with opportunities to develop outcomes in accordance with the Curriculum Framework of Western Australia (Curriculum Council, 1998). These conceptual strands included: Earth and Beyond, Energy and Change, Life and Living and Natural and Processed Materials. Each conceptual strand was allocated about eight weeks of instructional time. GTSP teachers pretested their students to determine the extent of their prior knowledge and modified the program removing content that students were familiar with in favour of tasks that extended the students understandings. In addition one process strand, Investigating Scientifically, was incorporated into the teaching programs so that investigation work could take place in the context of each of the conceptual strands. Investigating was allocated a total of about eight weeks of instructional time. Students were required to design an open-ended science investigation each term and produce a report that included details of planning, conducting, processing and evaluating the investigation. During the year student achievement in relation to the four conceptual strands and the process strand was captured and reported to parents. At MHS reporting in science requires data to be provided on each student's rank within the cohort so that grades can be awarded. This necessitates that all students within the cohort at MHS complete common science assessment items.

Teaching Practices in the Gifted and Talented Science Program

The Researcher's perceptions of the teaching practices within the GTSP were formed over a number of years. During the six years prior to this study, the Researcher and the G&T science class teacher worked closely as critical friends at MHS and in this capacity had many professional conversations concerning teaching philosophy and curriculum issues. The G&T science class teacher was selected as the Gifted and Talented Program Coordinator in the year prior to the commencement of the GTSP at MHS. This appointment was an acknowledgement of the expertise of the teacher in the field of gifted and talented education. Over the years prior to this study, the Researcher and GTSP coordinator had attended professional learning sessions concerning gifted education provided by the Gifted Education Research, Resource and Information Centre (GERRIC), University of New South Wales. At the commencement of this research, the GTSP at MHS had been operating for two years. Curriculum materials for the GTSP had been developed by the combined efforts of the Researcher and the GTSP coordinator.

Despite intimate knowledge of the GTSP by the Researcher, to ensure that analysis of the teaching methods in the G&T class was built on observations of implemented curriculum and not notions of intended curriculum, participant observation of the G&T class over the period of a school term was undertaken (Term 1 2007 Year 9 G&T class). Further triangulation was possible by making use of data collected from focus group interviews conducted with Year 8 GTSP and mainstream science students (Semester 2 2006). The following section outlines the teaching and learning principles of the GTSP, namely: constructivism, deep learning, self-regulation, curriculum and learning tasks, common assessment and authentic tasks. Following a statement of each principle, a discussion is included to outline related evidence of implementation of the principle from focus group interviews of Year 8 GTSP students and participant observation within the Year 9 G&T class of the GTSP.

Constructivism

Teachers of the GTSP are constructivist teachers who acknowledge that each student comes to class with their own prior knowledge that is modified by learning experiences and reshaped by social interaction. Pretests are advocated to determine the levels of understanding the students are working at in relation to a particular science outcome.

During participant observation (Lesson two, 2/2/07) the teacher provided each student in the G&T class with a three page pretest on static and current electricity that included 46 items. The teacher gauged the nature of each student's prior knowledge from their responses to the pretest. After completing the section on static electricity the teacher asked specific students to answer each question and invited the other students to indicate visually if they agreed or disagreed (thumbs up, agree; and thumbs down, disagree). The teacher gauged the students' understanding from this process.

Students in both the ALP and G&T classes were exposed to concept mapping and mind maps (Focus Group Interview, Student FA5, Student FD1 & Student FD 3, Semester 2 2006). Students were asked (Lesson one, 1/2/07) "to create a concept map and to use a pen to add things that you definitely know and a pencil to add things you think you know". In a subsequent lesson (Lesson two, 2/2/07) students were encouraged to modify their concept maps in light of the knowledge they had gained.

In the social context much learning results from dialogue with knowledgeable peers. In the classroom much of this dialogue takes place in the context of question and answer sessions. In the GTSP the teacher was observed tailoring her questions to suit the needs of the individual learner. In a lesson on conductors and insulators (Lesson 5, 8/2/07) the teacher was observed asking a range of questions from recall to analysis. A skilled teacher asks a question of who needs it most, that student for whom the question is in their zone of proximal development. Such a skill is an example of pedagogical content knowledge (Loughran, Berry, & Mulhall, 2007). Furthermore, such question and answer sessions allow a teacher to acknowledge alternative explanations and attend to students' points of view (Scott, 2007). Teachers of gifted students must view learning as a cooperative enterprise and be receptive to difficult questions coming from the audience (Watts & Pedrosa de Jesus, 2007).

Deep Learning

Teachers of the GTSP encourage a deep approach to learning so that students use the full range of levels of thinking of Bloom's taxonomy, for example they might memorise facts and concepts, but then go on to apply those concepts to novel situations (Taber & Corrie, 2007). Students were expected to learn science content and then apply their understanding, particularly during assessments such as the common assessment tasks (CATs). During focus group interview a GTSP student commented:

> We learn all of the stuff in the tests but in the test it doesn't give you it's like not a straight out question and then you know the answer to it. You've got to like read the question and then use what you know to infer something else. (Focus Group Interview, Student FA 5, Semester 2 2006)

During a lesson on electricity, after key terminology had been introduced, the teacher provided an opportunity for students to role play the components of a circuit. In a follow-up activity, students were provided with an opportunity to develop an analogy to help explain Ohm's law (Lesson 8, 13/2/07). The development of a suitable analogy requires that a student understands an abstract concept and is able to compare it with a more common concrete example to assist the understanding of others (Taber & Corrie, 2007). Thus the development of analogy develops deep learning.

During participant observation (Lesson 16, 27/2/07) the teacher asked the students to develop questions on electricity for a quiz board. The quiz board utilised the students' skills in circuitry as they needed to develop connections that would light up when contestants gave the correct response to a given question. The teacher issued a scaffold to assist students to develop questions of increasing complexity based on Bloom's taxonomy thus encouraging deep learning (Taber & Corrie, 2007). The development of the questions required students to discuss their understandings of the concept of electricity with one another to promoting meaningful learning (Scott, 2007).

Self-Regulation

Teachers of the GTSP encourage the students to become self-regulated learners, reflecting and using higher order thinking strategies autonomously, so they become independent, life-long learners. Students were provided with opportunities to be self-regulatory. In one assessment students were totally in control of how they proceeded with the design of a text book layout. They were initially involved in the construction of the marking rubric and then used the rubric to determine how they could improve their outcomes. Such an activity transfers the locus of control from teacher to students (Taber & Corrie, 2007). “Earlier in the year she gave us an assignment. We managed our own time and how we wanted to set it up. We had to study one of seven things and ours was excretion (laughs)” (Focus Group Interview, Student FA 3, Semester 2 2006). “We had control of how we set it out and stuff. She gave us the marking thing [rubric] so if we wanted to get a high mark we had to include this. We helped design it [the rubric]” (Focus Group Interview, Student FA 5, Semester 2 2006).

During participant observation (Lesson six, 9/2/07), the teacher provided each of the students with a cognitive organiser called a spider diagram on which they were to record what they understood about electricity. After completing this spider diagram, students completed a metacognitive worksheet which prompted reflection on their thinking by answering three questions, namely:

1. What new ideas, questions, insights, puzzles or connections do you have?
2. What was good about the thinking you did? Explain.
3. What could have been better? Explain. What will you do next time to improve your thinking?

Curriculum Design and Learning Tasks

Curriculum design within the GTSP involves compaction and differentiation (Macleod, 2005). Compaction involves looking closely at the curriculum in the light of student prior knowledge and carefully sequencing concepts to allow the teacher to introduce new ideas whilst minimising the time spent on concepts already mastered.

Differentiation addresses the different learning approaches, styles and rates of learning of gifted students (Pask, 1988; Schmeck, 1988; White, 1988) by including more open tasks that allow students to explore their own areas of interest and which afford flexibility of presentation.

At the start of the academic year 2007, the teacher of the G&T class of the GTSP used a pretest to assist her to gauge her students' prior knowledge of electricity (Lesson 2, 2/2/07). The pretest consisted of three pages of questions relating to static and current electricity, which was the topic to be studied by all Year 9 students in Term 1. To assess her students' understanding of static electricity the teacher read out 15 statements, relating to attraction and repulsion in different contexts, to which the students responded with a thumbs up agree or thumbs down disagree. The process took about five minutes. As a result the teacher quickly ascertained that the students were knowledgeable with respect to the charge law and was able to move straight onto a practical activity involving induced charges. Thus the concept of static charge which occupied at least a period of class time in other classes was replaced by a consideration of induced charge not covered in depth outside the GTSP. Since students in heterogeneous classes generally require at least a period looking at the fundamentals of static electricity such as the charge law, this was an example of compaction of the general science curriculum to suit the G&T class.

During participant observation (Lesson 8, 15/2/07), the students were provided with a creative writing task to demonstrate their understanding of the nature of electricity. This task allowed for lateral thinking on the part of the students. The students had to pretend they were an electron travelling around a circuit with several friends and to write an account of what they would experience. Students were able to present their accounts in different ways; for example, some drew cartoons, some made books. This task was an example of an extension activity not set outside of the G & T class (Taber & Riga, 2007).

Students conducted open science investigations that required them to develop their own design and plan methods which assisted them to learn inquiry skills (West, 2007). "It's good' we've got choice over what experiments we might try. If we want to test different things, we get to make our own experiments" (Focus Group Interview, Student FD 1, Semester 2 2006). In general science classes the Researcher's classroom experience suggests there was little evidence of open-ended investigations; questions for investigation were guided to a large extent by the teacher.

Common Assessment Tasks

Students in the GTSP are required to sit the same Common Assessment Tasks (CATs) as other students within the cohort so that students can be ranked. Along with evidence from class teachers, this ranking process provides a rationale for the movement of students into and out of the GTSP. All students in Year 9 at MHS complete two CATs for each conceptual strand.

The first CAT which took place during the period of participant observation (Lesson 20, 6/3/07) was a 30 minute test. The test comprised nine questions in total. Questions allowed students to demonstrate their level of understanding at Levels of the Curriculum Council progress maps for science (Education Department of Western Australia, 1998). Students needed to recall details of science content from the text. The CAT involved definitions (Level 2 and 3, 6 marks), circuit diagrams (Level 3 and 4, 7 marks); a calculation based on Ohm's Law (Level 4, 4 marks) a comparison of circuit types (Level 5, 5 marks); and a question on properties of resistors (Level 6, 6 marks).

The second CAT took place in Week 10 of the term (Lesson 30, 27/3/07). The CAT was a 60 minute test. The test had 10 multiple choice questions including: recall questions (Level 2, 4 marks), descriptions (Level 3, 8 marks), circuitry questions (Level 4, 8 marks), inferential questions (Level 5, 2 marks) and calculations (Level 5 and 6, 17 marks).

These tests were typical of the type of common assessment tasks that the MHS students completed for determination of grades for reporting purposes. The students' results on the CATs are also used to provide each student's rank within the MHS cohort.

Authentic Tasks

The teaching method in the GTSP is designed to promote higher order, creative, critical thinking in real world contexts to support the development of scientific literacy (Goodrum, 2004; Rennie, Goodrum, & Hackling, 2001; Tomlinson, 2005; Van Tassel-Baska, 2005; Venville & Dawson, 2004). Compaction of the curriculum provides time for the students to be involved in authentic, problem solving tasks which allow them to apply prior knowledge in the context of real-life situations (Abrams, 1998; Taber & Riga, 2007).

During 2006 when Year 8 GTSP students were studying the characteristics of living things they were provided with an opportunity to design a section of a text book as an authentic task. The students began by reviewing the content of their current textbook and regarded the book as lacking both in information and interest. The real-life problem identified was to develop a textbook that would suit the needs of gifted and talented Year 8 students, the audience for the textbook. Subsequently the class teacher and the students underwent a process to negotiate the criteria and standards for the assessment rubric that related to the development of a textbook section. Each student subsequently created a two page layout for the text book on one of the characteristics of living things and included questions that covered the higher levels of Bloom's taxonomy (Taber & Corrie, 2007). The pages were then peer assessed using the negotiated rubric that the students had helped to develop. "We had to design a text book on it [excretion], a two page textbook and include pictures, diagrams and text . . . We had control of how we set it out and stuff " (Focus Group Interview, Student FA 5, Semester 2 2006).

Students researched different forms of energy resources in lessons 29 and 30 (22/3/07, 23/3/07). The activity was set up using a jigsaw strategy with home groups and expert groups. Students in expert groups were required to explain how electricity could be generated from a designated energy resource, review the advantages and disadvantages of the energy resource and include points of interest, the expert groups then disbanded and information was shared amongst the home groups which included experts on each of a range of energy resources.

Following their research, GTSP Year 9 students typically went on to apply their understanding of alternative energy sources to an authentic task. This task involved a hypothetical scenario set in Antarctica. Supplementary data was provided on hours of sunshine, tides and wind speeds and students were asked to write an essay indicating the best energy source to provide for a small tourist resort and justify their decision based on their research. This task was not set during the period of participant observation in 2006. Time constraints due to the amount of content on the science curriculum were cited by the teacher as the reason for this. Between the research component and the CAT, set at the conclusion of the topic on electricity, there was only one period of science which was used for consolidation purposes. This time constraint could have been the basis of the student comment, "It's annoying when we run out of time to finish certain projects" (Student Response on Teacher Satisfaction Poll, Year 8 G&T class, Term 4 2006). This was an example of a situation as discussed in the literature where curriculum and institutional constraints worked against the teacher's understanding of best practice (Taber, 2007a).

Finding 4.2

Evidence of implementation of teaching and learning principles in relation to: constructivism, deep learning, self-regulation, curriculum and learning tasks and common assessment were noted during focus group interviews and during participant observation by the Researcher. The CATs required students to recall significant science content from the text and also to apply their understanding to achieve high levels of outcomes. The teachers of the GTSP provided flexibility by allowing students opportunities to demonstrate outcomes in a variety of ways. This afforded differentiation even though students were completing the same task. Authentic tasks were evident within the GTSP, but time constraints prevented full implementation of the planned authentic task during Term 1 2007.

Classroom Environment

The literature suggests that a tight fit between the needs of adolescents and the classroom environment facilitates optimum motivation (Turner & Meyer, 1999) and influences social and academic goals (Mansfield, 2001). Therefore in this study GTSP students' perceptions of their preferred and actual classroom environment were measured. The classroom environment is shaped primarily by the actions of the classroom teacher who is striving to close the gap between their own preferred classroom environment and their perception of the actual classroom environment. For this reason the classroom environment measure was also administered to teachers of the GTSP classes.

Preferred and Actual Classroom Environment: Student

The Revised Individualised Classroom Environment Questionnaire (rICEQ) measures students' perceptions of aspects of individualisation of the curriculum on five dimensions: *Personalisation* (Pe), *Participation* (Pa), *Independence* (Id), *Investigation* (Iv) and *Differentiation* (Di). To compare students' perceptions about their preferred classroom learning environment and the actual classroom environment, consenting Year 8 students in the G&T class (n=21) and ALP class (n=17) completed a preferred rICEQ and actual rICEQ in Term 3 2006. A paired sample *t* test was conducted using SPSS to investigate the degree of alignment between the preferred and actual classroom data for each class (G&T and ALP) in each of the five dimensions. The maximum possible score for each dimension is 40. Results are shown in Tables 4.2 and 4.3.

Focus group interviews also shed light on the students' perceptions of their perceived ideal science classroom and their actual classroom environment. Qualitative data in the form of focus interview comments from Year 8 students in the GTSP classes have been provided to supplement the survey data where appropriate.

It can be seen in Table 4.2 that the students' mean scores for the each dimension of the preferred classroom environment for the G&T class were higher than the mean scores for the actual classroom environment. There was no significant difference between the means of the survey results of the preferred classroom environment and perceptions of the actual classroom environment for the *Personalisation*, *Participation* and *Differentiation* dimensions. However, there was a significant difference between the means relating to what the G&T students prefer and the actual classroom environment in relation to the *Independence* $t(20)=2.259$, $p<.05$ and *Investigation* $t(20)=2.494$, $p<.05$ dimensions. "I expected to have a bit more freedom" (Focus Group Interview, Student FD1, Semester 2 2006). "I wanted to use all the dangerous things and make explosions and wear coats and glasses, but it wasn't like that. We just mixed powder into water and stuff" (Focus Group Interview, Student FA5, Semester 2 2006).

A lower mean score (25.24) for the actual *Differentiation* dimension, possibly reflects the students' lack of understanding of the nature of a differentiated curriculum. However, it also indicates that the level of differentiation in the G&T classroom needs to be reviewed. "I thought it would provide a lot more opportunities [science at high school] and new ways to learn. . . . I thought there might be a few new ways of experimenting and science projects" (Focus Group Interview, Student FD6, Semester 2 2006).

There was a greater degree of spread in the scores for the actual *Personalisation* dimension than other dimensions (6.132). Students at different stages of maturity are likely to differ in their need for personal attention by the teacher and it is always a challenge for the teacher to divide their attention equally between the students. These factors are likely to result in differing perceptions of the degree to which the teacher is attending to the needs of individual students.

Table 4.2

Students' Preferred and Actual rICEQ Scores on Five Dimensions (Year 8 G&T Class)

Dimension	Mean	N	Std. Dev	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
Personalisation Preferred	30.76	21	5.029	1.097	1.984	20	0.061
Personalisation Actual	28.00	21	6.132	1.338			
Participation Preferred	31.48	21	3.124	0.682	1.140	20	0.268
Participation Actual	30.43	21	4.273	0.932			
Independence Preferred	31.86	21	3.719	0.811	2.259	20	0.035*
Independence Actual	29.10	21	4.636	1.012			
Investigation Preferred	32.33	21	4.270	0.932	2.494	20	0.021*
Investigation Actual	29.14	21	5.360	1.170			
Differentiation Preferred	26.00	21	5.577	1.217	0.648	20	0.524
Differentiation Actual	25.24	21	4.381	0.956			

Note * *p*<.05 two-tailed, paired *t* test

Table 4.3

Students' Preferred and Actual rICEQ Scores on Five Dimensions (Year 8 ALP Class)

Dimension	Mean	N	Std. Dev	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
Personalisation Preferred	29.24	17	5.203	1.262	0.586	16	0.566
Personalisation Actual	28.71	17	4.356	1.056			
Participation Preferred	31.06	17	3.665	0.889	-0.184	16	0.857
Participation Actual	31.18	17	3.877	0.940			
Independence Preferred	29.47	17	5.907	1.433	2.590	16	0.020*
Independence Actual	26.00	17	3.808	0.924			
Investigation Preferred	29.59	17	5.149	1.249	1.506	16	0.152
Investigation Actual	28.35	17	4.729	1.147			
Differentiation Preferred	24.94	17	5.117	1.241	2.321	16	0.034*
Differentiation Actual	21.35	17	4.122	1.000			

Note * *p*<.05 two-tailed, paired *t* test

Table 4.3 indicates that with the exception of the *Participation* dimension, the students' mean scores for the preferred classroom environment for the ALP class were higher than the mean scores for the actual classroom environment as perceived by the students. There was no significant difference between the preferred and actual means for the *Personalisation, Participation* and *Investigation* dimensions. However, there was a significant difference between the means relating to what the ALP students preferred and the actual classroom environment in relation to *Independence,* as was the case with the G&T class, $t(16)=2.590$, $p<.05$. "I don't like sitting in specific seating positions" (Focus Group Interview, Student FA3, Semester 2 2006). "I expected that we would get to chose our science experiments and where we get to sit" (Focus Group Interview, Student FD7, Semester 2 2006).

There was also a significant difference between the means relating to what the ALP students prefer and the actual classroom environment in relation to the *Differentiation* dimension $t\ (16) =2.321$, $p<.05$. The data show that the lowest mean score is for the actual *Differentiation* dimension (21.35). Despite the students indicating a low level of preference for *Differentiation* (24.94), the level of *Differentiation* in the ALP classroom needs to be addressed, particularly in light of the significant difference between the preferred and actual classroom survey results. "I wanted to learn interesting stuff that I hadn't learnt before . . . .and get onto higher levels . . . . like learning beyond the basic things" (Focus Group Interview, Student FA5, Semester 2 2006).

Finding 4.3

The teacher of the Year 8 G&T class provided a classroom environment that had a close fit with the preferred classroom environment of the students in relation to *Personalisation, Participation* and *Differentiation*, however, practices in the classroom in relation to *Independence* and *Investigation* need to be examined.

The teacher of the Year 8 ALP class provided a classroom environment that had a close fit with the preferred classroom environment of the students in relation to

Personalisation, Participation and *Investigation*, however, practices in the classroom in relation to *Independence* and *Differentiation* need to be reviewed.

Preferred and Actual Classroom Environment: Teacher

The teachers of the Year 8 G&T and ALP classes were also surveyed about their perceptions of their preferred classroom environment and the actual classroom environment. Results are shown in the Table 4.4 below.

Table 4.4

G&T and ALP Teacher's Perceptions of their Preferred and Actual Classroom Environments on Five Dimensions of the rICEQ

Teacher		Teacher scores on dimensions of the rICEQ				
		Personalisation	Participation	Independence	Investigation	Differentiation
G&T	Preferred (TP)	40	37	34	39	40
	Actual (TA)	32	36	29	28	26
	Difference (TP-TA)	8*	1	5	11*	14*
ALP	Preferred (TP)	30	30	20	29	28
	Actual (TA)	24	29	25	25	25
	Difference (TP-TA)	6	1	-5*	4	3

Note * these values represent misalignment between preferred and actual scores

The two teachers varied in their perceptions of an ideal classroom environment. The maximum score possible for each dimension was 40. The teacher of the G&T class indicated a preference for a very high degree of *Personalisation* (40), *Participation* (37), *Investigation* (39) and *Differentiation* (40), whilst her preference for student *Independence* (34) was a little lower. The teacher of the ALP class had lower preference values than the G&T teacher in all dimensions for her ideal classroom environment with scores of *Personalisation* (30), *Participation* (30), *Investigation* (29) and *Differentiation* (28). Again the teacher's preference for student *Independence* was lower (20).

Teachers will perceive satisfaction when their actual classroom environment (TA) and their preferred classroom environment (TP) are in alignment (TP–TA=0). The data indicate that each teacher had different degrees of alignment across the dimensions. In Table 4.4 the differences (TP-TA) indicate the degree of misalignment for each dimension.

In the G&T class the teacher managed to teach in a way that matched her perception of her ideal in the *Participation* dimension. However, there were large misalignments in the teacher's perception of her ability to match her ideals in the *Personalisation*, *Investigation* and *Differentiation* dimensions. As an experienced G&T classroom practitioner and coordinator of the GTSP at MHS, the teacher's knowledge of best practice pedagogy in the area of gifted education gave rise to her high preferred scores in the five dimensions surveyed. As a reflective practitioner the teacher was constantly aware of constraints that limited her ability to provide the ideal learning environment for her students, this in turn manifested in the perceived misalignment between her preferred and actual rICEQ score.

Although the teacher of the ALP class was a less experienced science educator and this was her first year teaching in the GTSP, she appeared to have more success at achieving her ideal given that the differences between her ideal and actual classroom scores were less pronounced than those of the G&T class teacher. Again the closest alignment was in the *Participation* dimension. Of note is the difference between the preferred and actual scores in the *Independence* dimension which indicate that the ALP teacher perceived that the students had more independence than she would prefer. It may be that the perceived alignment with respect to the five dimensions was the result of the lower preferred scores and a less critical appraisal of what had been achieved in the classroom. At the time of survey the ALP teacher had not yet attended targeted professional development related to best practice in relation to teaching gifted and talented students.

Table 4.5 below shows the mean results of the preferred classroom environment and actual classroom of the students in each of the classes as a comparison with those of their teacher. Since the preferred classroom environment of the students differed from that of their teacher, even if the teachers perceived they were not achieving their personal ideal, they may have been providing the ideal classroom environment of their students. This situation would be indicated if the student difference (SP-SA) was less than the difference (TP-TA) for a particular dimension.

Table 4.5

Comparisons of Students' and Teacher's Perceptions of their Preferred and Actual Classroom Environments (Year 8 G&T and ALP Classes)

		Scores on the rICEQ dimensions				
		Personalisation	Participation	Independence	Investigation	Differentiation
G&T Students (n=21)	Preferred (SP)	30.76	31.48	31.86	32.33	26.00
	Actual (SA)	28.00	30.43	29.10	29.14	25.24
	Difference (SP-SA)	2.76*	1.05	2.76	3.19*	0.76*
G&T Teacher	Difference (TP-TA)	8*	1	5	11*	14*
ALP Students (n=17)	Preferred (SP)	29.24	31.06	29.47	29.59	24.94
	Actual (SA)	28.71	31.18	26.00	28.35	21.35
	Difference (SP-SA)	0.53*	-0.12*	3.47*	1.24	3.59
ALP Teacher	Difference (TP-TA)	6*	1*	-5*	4	3

Note * these values represent misalignment between students' and teacher's perceptions

In the case of the G&T class, although the teacher difference values (TP-TA) indicated a degree of misalignment particularly in the *Personalisation*, *Investigation* and *Differentiation* dimensions, the students' difference values (SP-SA) were not as pronounced. Thus the teacher was closer to achieving the students' ideal classroom environment than she was of achieving her own.

In the ALP class the results were varied. In terms of the *Personalisation, Participation,* and *Investigation* dimensions the teacher was closer to matching the student's preferences than her own. The teacher wanted marginally more in terms of student participation than her students. In the *Differentiation* dimensions the teacher was closer to achieving her own ideal than that of the students. In the *Independence* dimension their appeared to be a mismatch, the teacher perceived that the students had too much autonomy (TP-TA = -5) but the students wanted still more *Independence* (SP-SA= 3.47). Since ultimately the classroom teacher decides how a particular concept is taught, it seems incongruous that the students would have greater autonomy than the teacher intended. During 2006 the ALP teacher was implementing certain lesson plans and assessments developed by the G&T class teacher who was acting as a mentor. This may have resulted in the ALP teacher's perception that the students had a greater level of autonomy in learning than her ideal.

Interestingly, whilst both teachers were striving for slightly higher degree of student *Participation*, the G&T class wanted that greater degree of *Participation* whereas students in the ALP class believed they were participating marginally beyond their perceived optimal level.

Finding 4.4

Each teacher in the GTSP had higher preferred classroom environment preferences for *Personalisation*, *Participation*, *Investigation* and *Differentiation* than *Independence*. The preferred scores for the teacher of the G&T class were markedly higher than the teacher of the ALP class, particularly with respect to *Independence* and *Differentiation*. These variations in preferred classroom environments between the teachers were likely to be the product of many factors. However, the teacher of the G&T class was far more experienced with teaching gifted and talented students and this likely played a major part in shaping her preferences in terms of the ideal classroom environment for such students.

In the context of this study, misalignment denotes a marked difference between the preferred and actual environment scores for a teacher when compared to the difference between the preferred and actual environment scores for their students. The greatest misalignments of perception were experienced within the G&T classroom in the *Investigation* and *Differentiation* dimensions, where the difference between the preferred and actual scores of the teacher were much greater than that of her students. The perception of the ALP teacher with respect to *Independence* was at odds with that of her students, the teacher striving for less independence for her students, whilst her students wanted more independence. Both teachers recorded a greater difference between their preferred and actual classroom environment than their students in the *Personalisation* dimension.

Changes to Students' Preferred Classroom Environment during Year 8

Year 8 students in the G&T and ALP classes completed a preferred rICEQ in Term 1 and Term 3 2006 to determine if the preferred classroom environment of the students changed over time. Data were analysed using a paired *t* test using SPSS. Results are shown in Tables 4.6 and 4.7.

It can be seen in Table 4.6 that for the G&T class the mean for the preferred classroom environment declined over the course of the year on four of the dimensions: *Personalisation* (Term1, 31.81, Term 3, 30.76), *Participation* (Term1, 32.29, Term 3, 31.48), *Investigation* (Term1, 32.38, Term 3, 32.33) and *Differentiation* (Term1, 26.81, Term 3, 26.00). In the case of the *Independence* dimension the mean score increased from 31.86 to 32.38. However, since the probability values are greater than 0.05 for each dimension this indicates that there is no significant difference between the means in Term 1 and Term 3.

Table 4.6

Year 8 G&T Students' Preferred Classroom Environment in Term 1 and 3 of 2006

Dimension	Mean	N	Std. Dev.	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
Personalisation Term 1	31.81	21	4.654	1.016	1.478	20	0.155
Personalisation Term 3	30.76	21	5.029	1.097			
Participation Term 1	32.29	21	2.513	0.548	1.115	20	0.278
Participation Term 3	31.48	21	3.124	0.682			
Independence Term 1	30.67	21	3.679	0.803	-1.435	20	0.167
Independence Term 3	31.86	21	3.719	0.811			
Investigation Term 1	32.38	21	3.694	0.806	0.054	20	0.957
Investigation Term 3	32.33	21	4.270	0.932			
Differentiation Term 1	26.81	21	4.676	1.020	0.669	20	0.511
Differentiation Term 3	26.00	21	5.577	1.217			

Table 4.7

Year 8 ALP Students' Preferred Classroom Environment in Term 1 and 3 of 2006

Dimension	Mean	N	Std. Dev.	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
Personalisation Term 1	30.41	17	4.214	1.022	1.614	16	0.126
Personalisation Term 3	29.24	17	5.203	1.262			
Participation Term 1	30.29	17	3.368	0.817	-0.942	16	0.360
Participation Term 3	31.06	17	3.665	0.889			
Independence Term 1	27.94	17	4.337	1.052	-1.081	16	0.296
Independence Term 3	29.47	17	5.907	1.433			
Investigation Term 1	27.29	17	3.670	0.890	-2.012	16	0.061
Investigation Term 3	29.59	17	5.149	1.249			
Differentiation Term 1	24.35	17	3.639	0.883	-0.428	16	0.674
Differentiation Term 3	24.94	17	5.117	1.241			

Furthermore data from focus group interview (Semester 2 2006) indicated that Year 8 G&T students had not changed their preferences over the year. Only one student made a comment that indicated a shift which related to the *Independence* dimension. "We have a lot more respect for the teacher and we find they are usually right. The teacher does a lot of experiments with us and it's an easy learning environment. In science everything is well planned" (Focus Group Interview, Student FD6, Semester 2 2006).

Table 4.7 above indicates that for the ALP class, the means of the *Participation*, *Independence*, *Investigation* and *Differentiation* dimensions increased over the course of the year. In the case of the *Personalisation* dimension the mean score decreased. However, since the probability values are greater than 0.05 for each dimension this indicates that there is no significant difference between the Term 1 and 3 means.

When students were asked if their ideal classroom environment had changed over the year at focus group interview (Semester 2 2006) all of the Year 8 ALP students interviewed stated that they had not changed their preferences over the year.

Finding 4.5

There was no significant change in the preferred classroom environment of the Year 8 GTSP G&T or ALP students between Term 1 and Term 3 2006.

Change to Students' Preferred Classroom Environment between the Beginning of Year 8 and the End of Year 9

Students in the Year 9 G&T class (n=23) and ALP class (n=15), who had completed surveys in 2006 as Year 8s, completed a preferred ICEQ in Term 4 2007 to determine if their preferred classroom environment had changed over the preceding period of two academic years. Data were analysed using a paired *t* test using SPSS. Results are shown in Table 4.8 and 4.9.

As can be seen from the data in Tables 4.8 and 4.9 there were changes in some dimensions of the preferred classroom environment over the longer duration in both the G&T and ALP classes. In the G&T class (Table 4.8) student preference for *Investigation* showed a significant decline *t* (22) =2.341, *p*<.05; *d* = -0.56 between Term 1 2006 and Term 4 2007. The effect size for this analysis was medium according to Cohen (1988). In the ALP class (Table 4.9) analysis of the survey results indicated that student preferences for a greater degree of *Participation t* (14) =2.214, *p*<.05; *d* = 0.70 and *Independence t* (14) =2.884, *p*<.05; *d* = 0.91 were significant between Term 1 2006 and Term 4 2007. The effect sizes for this analysis were found to be medium for *Participation* and to exceed Cohen's (1988) convention for a large effect for *Independence.*

Table 4.8

Results of a Paired t Test Comparing Preferred Classroom Environment over Time (G&T Class Year 8 to Year 9)

Dimension	Mean	N	Std. Dev.	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
Personalisation Term 1 2006	31.96	23	4.666	0.973	0.089	22	0.930
Personalisation Term 4 2007	31.87	23	4.664	0.973			
Participation Term 1 2006	32.87	23	2.897	0.604	1.600	22	0.124
Participation Term 4 2007	31.74	23	3.840	0.801			
Independence Term 1 2006	30.35	23	3.638	0.759	-1.436	22	0.165
Independence Term 4 2007	31.57	23	3.382	0.705			
Investigation Term 1 2006	32.57	23	3.501	0.730	2.341	22	0.029*
Investigation Term 4 2007	30.35	23	4.427	0.923			
Differentiation Term 1 2006	26.48	23	4.708	0.982	0.348	22	0.731
Differentiation Term 4 2007	26.00	23	5.461	1.139			

Note * *p*<.05 two-tailed, paired *t* test

Table 4.9

Results of a Paired t Test Comparing Preferred Classroom Environment over Time (ALP Class Year 8 to Year 9)

Dimension	Mean	N	Std. Dev.	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
Personalisation Term 1 2006	30.93	15	3.826	.988	-0.367	14	0.719
Personalisation Term 4 2007	31.40	15	3.979	1.027			
Participation Term 1 2006	30.40	15	2.823	0.729	-2.214	14	0.044*
Participation Term 4 2007	32.73	15	3.788	0.978			
Independence Term 1 2006	29.40	15	4.102	1.059	-2.884	14	0.012*
Independence Term 4 2007	33.07	15	3.936	1.016			
Investigation Term 1 2006	27.40	15	3.906	1.009	-0.852	14	0.409
Investigation Term 4 2007	28.53	15	4.969	1.283			
Differentiation Term 1 2006	24.73	15	3.731	0.963	0.362	14	0.723
Differentiation Term 4 2007	24.20	15	3.986	1.029			

Note * p<.05 two-tailed, paired t test

Finding 4.6

There were significant changes to the classroom environment preferred by both the G&T and ALP students between Term 1 2006 and Term 4 2007, however, the dimensions in which significant changes were noted were not consistent between classes. G&T students declined in their preference for *Investigation* while ALP students increased in their preference for *Participation* and *Independence*. The Researcher's classroom experience suggests that the decline in *Investigation* within the G&T class is likely to be related to the demands of writing up the investigations carried out in a prescribed fashion. Student motivation is enhanced when findings can be presented to each other or an audience using modes they consider most adaptive (West, 2007).

Student Perceptions of their Satisfaction with their Classroom Teacher

A key factor affecting student perceptions of their classroom environment is the teaching philosophy of the classroom teacher. Most importantly this affects the way the teacher approaches teaching and assessment, but it also affects social relationships and group dynamics within the classroom. By the end of Year 8, classroom environment (rICEQ) surveys had been conducted with the GTSP students and participant observation of the Year 9 G&T class had been proposed as a means of exploring the classroom environment further. It was decided that analysis of results and triangulation of data would be more meaningful if the G&T students were to retain the same class teacher in Year 9. Consequently the Researcher approached the Year 8 G&T class teacher to discuss the proposed research design. The teacher agreed in principle to retain the class in Year 9, with the caveat that the students generally were in agreement. An anonymous poll of students (n=24), called a teacher satisfaction poll, was taken. Students were asked whether teacher X should continue as their teacher and asked to respond: yes, no or undecided. Students were asked to list the pros and cons to their science education if they retained teacher X.

Results of the survey were yes (n=16), no (n=3) and undecided (n=5). As a result of the survey the teacher agreed to continue with the G&T class in Year 9. The total number of comments were pros (n=103) and cons (n=41). Analysis of comments resulted in three themes: the first theme related to the personal traits of the G&T teacher, the second theme was organised around those comments that pertained to classroom pedagogy and the third theme encompassed those statements that voiced students' feelings about retaining their current teacher as their science teacher the following year. The number of comments related to each theme is indicated in Table 4.10 with examples of students' comments in relation to each theme.

After a year in the G&T class, students were able to articulate their level of satisfaction with their teacher. On a personal level while the teacher was seen as inflexible by some, many commented on the level of personal interest displayed. The demands of the curriculum resulted in some students feeling that theoretical work was taking precedence over more stimulating projects; however, the teacher appeared to be capturing the students' interest and was able to explain complex concepts clearly. There were an equal number of comments relating to the benefit of retaining the teacher as there were commenting on the need to experience other teaching styles.

Table 4.10

Results of a Teacher Satisfaction Poll with Themes Relating to Student Satisfaction with their Class Teacher (Year 8 G&T)

Pros (n= 103)	Cons (n= 41)
Personal traits (n=59) “Tolerant” “Knows everyone’s personality”	**Personal traits** (n=6) “Inflexible (sometimes)”
Teaching and assessment (n=40) “Logical and effective teaching methods” “Makes science fun and interesting” “She listens to our questions and answers them in lots of detail” “Honest about faults” “Let’s us choose our own way to do things”	**Teaching and assessment** (n=31) “Quite demanding” “It’s annoying when we run out of time to finish certain projects” “We do more theoretical work than experiments”
Retention of teacher (n=4) “Won’t have to adjust to another teacher”	**Retention of teacher** (n=4) “I don’t think it’s good to have the same teacher twice. There is no diversity” “Won’t experience other teaching styles”

Finding 4.7

In general students in the Year 8 G&T class were happy to retain their teacher in Year 9. Most students were satisfied with the personal and professional qualities of their teacher. When dissatisfaction was expressed it related to the cognitive demand of the course which precluded time spent on individual projects and the need to experience other teaching styles.

Summary of Findings

Table 4.11 indicates a summary of the findings in relation to the nature of the teaching and learning context within the GTSP at MHS.

Table 4.11

Summary of Findings Relating to the Nature of the GTSP

	Finding
4.1	Students in the GTSP G&T and ALP classes were selected on the basis of their HAST mathematics scores which were used as an indicator of their aptitude for science. There was a significant difference in HAST scores between these two classes, but students in each class were likely to be more closely matched in aptitude for science than if they had entered normal heterogeneous mainstream science classes at MHS for which no such selection process occurs. This homogeneity was likely to improve the academic learning that occurs from social interactions between like peers in classrooms.
4.2	Evidence of implementation of teaching and learning principles in relation to: constructivism, deep learning, self-regulation, curriculum and learning tasks and common assessment were noted during focus group interviews and during participant observation by the Researcher. The CATs required students to recall significant science content from the text and also to apply their understanding to achieve high levels of outcomes. The teachers of the GTSP provided flexibility by allowing students opportunities to demonstrate outcomes in a variety of ways. This afforded differentiation even though students were completing the same task. Authentic tasks were evident within the GTSP, but time constraints prevented full implementation of the planned authentic task during Term 1 2007.
4.3	The Year 8 G&T teacher provided a classroom environment that had a close fit with the students' preferred classroom environment in relation to *Personalisation, Participation and Differentiation*, however, classroom practices in relation to *Independence* and *Investigation* need to be examined. The Year 8 ALP teacher provided a classroom environment that had a close fit with the students' preferred classroom environment in relation to *Personalisation, Participation* and *Investigation*, however, classroom practices in relation to *Independence and Differentiation* need to be reviewed.
4.4	Each teacher in the GTSP had higher preferred classroom environment preferences for *Personalisation*, *Participation*, *Investigation* and *Differentiation* than *Independence*. The preferred scores for the teacher of the G&T class were markedly higher than the teacher of the ALP class, particularly with respect to *Independence* and *Differentiation*. These variations in preferred classroom environments between the teachers were likely to be the product of many factors. However, the teacher of the G&T class was far more experienced with teaching gifted and talented students and this likely played a major part in shaping her preferences in terms of the ideal classroom environment for such students. In the context of this study, misalignment denotes a marked difference between the preferred and actual environment scores for a teacher when compared to the difference between the preferred and actual environment scores for their students. The greatest misalignments of perception were experienced within the G&T classroom in the *Investigation* and *Differentiation* dimensions, where the difference between the preferred and actual scores of the teacher were much greater than that of her students. The perception of the ALP teacher with respect to *Independence* was at odds with that of her students, the teacher striving for less independence for her students, whilst her students wanted more independence. Both teachers recorded a greater difference between their preferred and actual classroom environment than their students in the *Personalisation* dimension.
4.5	There was no significant change in the preferred classroom environment of the Year 8 GTSP G&T or ALP students between Term 1 and Term 3 2006.
4.6	There were significant changes to the classroom environment preferred by both the G&T and ALP students between Term 1 2006 and Term 4 2007, however, the dimensions in which significant changes were noted were not consistent between classes. G&T students declined in their preference for *Investigation* while ALP students increased in their preference for *Participation* and *Independence*. The Researcher's classroom experience suggests that the decline in *Investigation* within the G&T class is likely to be related to the demands of writing up the investigations carried out in a prescribed fashion. Student motivation is enhanced when findings can be presented to each other or an audience using modes they consider most adaptive (West, 2007).
4.7	In general students in the Year 8 G&T class were happy to retain their teacher in Year 9. Most students were satisfied with the personal and professional qualities of their teacher. When dissatisfaction was expressed it related to the cognitive demand of the course which precluded time spent on individual projects and the need to experience other teaching styles.

CHAPTER 5

THE EFFECT OF THE GIFTED AND TALENTED SCIENCE PROGRAM ON LEARNING APPROACH, SELF-REGULATED LEARNING AND SELF-EFFICACY OF LEARNING

The outcomes of a successful program cannot be measured solely by academic achievement. In order to prepare students adequately for life beyond school, educators strive to provide students with a skill set that will facilitate life-long autonomous learning. This is particularly important in an age where it is likely that individuals will need to retrain several times over their lifespan for continued purposeful employment. This chapter focuses on Research Question 2 and looks at how and why the experiences of students within the GTSP at MHS affect learning approach, self-regulated learning and self-efficacy of learning. Data to support the findings has been obtained from survey data, participant observation, student one-on-one interviews and artefacts.

Learning Approach

To track the students' learning approaches over time the Learning Process Questionnaire (LPQ) (Biggs, 1987a) was administered in Term 1 Year 8, Term 3 Year 8 and Term 4 Year 9 to the G&T and ALP classes of the GTSP.

At MHS, as is the case with most schools, a number of students enrol and others leave throughout the academic year. During the period of this research there was some movement of students into and out of the GTSP program. As a result of this student movement, the composition of the G&T class in Year 9 was not the same as in Year 8. Some students from the Year 8 ALP class 2006 were promoted to the Year 9 G&T class 2007 on the basis of their school performance and after discussion between the class teacher and G&T coordinator to assess their suitability prior to the transfer.

To track any changes in the GTSP students' learning approaches over time it was necessary to confine analysis of data to those students who had been in the GTSP program for the two year period (Year 8 through Year 9). Furthermore, although all students in the G&T and ALP classes consented to surveys in Year 9, this was not the case in Year 8. Some students in the G&T class 2007 (n=6) had declined to be surveyed when they were in Year 8, but agreed in Year 9. These students' results could not be used to assess changes in learning approach over time as the data sets were incomplete for such individuals.

Tables 5.1 and 5.2 show the changes in the average scores for the LPQ surface, deep and achieving dimensions during Year 8 (Term 1 compared with Term 3 2006) and between the start of Year 8 (Term 1 2006) and end of Year 9 (Term 4 2007) for students in the ALP class (n=14) and G&T class (n=23) during Year 9. To examine the change in learning approach over time, data were analysed using paired *t* tests using SPSS. The null hypothesis tested was that there was no change to the students' mean scores on the LPQ between the first and final assessment.

Gifted and Talented Class of the GTSP

The data for the G&T class (Table 5.1) show that mean scores for the surface dimensions of the LPQ increased over Year 8 and continued to increase over Year 9. The increase in score for the surface dimension over the two year period was 1.52 from a mean of 33.87 to 35.39. However since the probability values are greater than 0.05 for each comparison, this indicates that there was no significant difference in the means between Term 1 Year 8 2006 and Term 4 Year 9 2007.

For the deep dimension the increase in score was 0.13 from 37.39 (Term 1 Year 8) to 37.52 (Term 4 Year 9). It is to be noted that the highest mean score for the deep dimension for the G&T class as surveyed by LPQ was during Term 3 Year 8 (39.39). Again since the probability values are greater than 0.05 for each comparison this indicates that there was no significant difference in the means between Term 1 Year 8 2006 and Term 4 Year 9 2007.

For the achieving dimension, the data for the G&T class (Table 5.1) show that mean scores for the LPQ decreased over Year 8 and continued to decrease over Year 9. The decrease in score for the achieving dimension over the two year period was 1.96 from a mean of 42.35 to 40.39. Again there was no significant difference in the means for the achieving dimension between Term 1 Year 8 2006 and Term 4 Year 9 2007.

Accelerated Learning Class of the GTSP

The data for the ALP class (Table 5.2) also show an increase in the mean scores for the surface dimensions of the LPQ over the two years from Year 8 to Year 9. The increase in score for the surface dimension over the two year period was 2.86 from a mean of 35.14 to 38.00. This was a more marked increase than for the G&T class. However, since the probability values are greater than 0.05 for each comparison this indicates that there was no significant difference in the means between Term 1 Year 8 2006 and Term 4 Year 9 2007.

For the deep dimension, there was a decrease in mean score of 0.85 from 37.64 (Term 1 Year 8) to 36.79 (Term 4 Year 9). It is to be noted that the highest mean score for the deep dimension for the ALP class as surveyed by LPQ was also during Term 3 Year 8 (37.71). Again, there was no significant difference in the means between Term 1 Year 8 2006 and Term 4 Year 9 2007.

For the achieving dimension, the data for the ALP class (Table 5.2) show that mean scores for the LPQ decreased over Year 8 and continued to decrease over Year 9. The decrease in score for the achieving dimension over the two year period was 5.14 from a mean of 40.57 to 35.43. This difference in means between Term 1 Year 8 2006 and Term 4 Year 9 2007 was found to be statistically significant t (13) =2.429, p<.05; d = 0.77. The effect size was found to be medium for this analysis (J. Cohen, 1988).

Table 5.1

Results of a Paired t Test Comparing the Students' Learning Approach over Time (G&T Class Year 8 2006 to Year 9 2007)

Dimension	Mean	N	Std. Dev.	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
LPQ Surface Term1 2006	33.87	23	7.226	1.507	-0.858	22	0.400
LPQ Surface Term 3 2006	34.91	23	6.522	1.360			
LPQ Deep Term 1 2006	37.39	23	8.648	1.803	-1.192	22	0.246
LPQ Deep Term 3 2006	39.39	23	7.919	1.651			
LPQ Achieving Term 1 2006	42.35	23	7.309	1.524	0.300	22	0.767
LPQ Achieving Term 3 2006	41.96	23	8.337	1.738			
LPQ Surface Term 1 2006	33.87	23	7.226	1.507	-1.166	22	0.256
LPQ Surface Term 4 2007	35.39	23	6.162	1.285			
LPQ Deep Term 1 2006	37.39	23	8.648	1.803	-0.062	22	0.951
LPQ Deep Term 4 2007	37.52	23	7.179	1.497			
LPQ Achieving Term 1 2006	42.35	23	7.309	1.524	1.038	22	0.310
LPQ Achieving Term 4 2007	40.39	23	6.315	1.317			

Table 5.2

Results of a Paired t Test Comparing the Students' Learning Approach over Time (ALP Class Year 8 2006 to Year 9 2007)

Dimension	Mean	N	Std. Dev.	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
LPQ Surface Term 1 2006	35.14	14	3.840	1.026	-.276	13	.787
LPQ Surface Term 3 2006	35.50	14	4.864	1.300			
LPQ Deep Term 1 2006	37.64	14	5.183	1.385	-.038	13	.970
LPQ Deep Term 3 2006	37.71	14	5.797	1.549			
LPQ Achieving Term 1 2006	40.57	14	6.333	1.693	1.432	13	.176
LPQ Achieving Term 3 2006	38.14	14	6.871	1.836			
LPQ Surface Term 1 2006	35.14	14	3.840	1.026	-1.928	13	.076
LPQ Surface Term 4 2007	38.00	14	5.698	1.523			
LPQ Deep Term 1 2006	37.64	14	5.183	1.385	.366	13	.720
LPQ Deep Term 4 2007	36.79	14	8.097	2.164			
LPQ Achieving Term 1 2006	40.57	14	6.333	1.693	2.429	13	.030*
LPQ Achieving Term 4 2007	35.43	14	7.024	1.877			

Note * p<.05 two-tailed, paired *t* test

Finding 5.1

The learning approach scores, as measured by LPQ survey, showed similar trends in both the G&T and ALP classes. The scores for surface approach showed a small and non-significant increase over the two year period, while the scores for the deep approach showed a small and non-significant decline. There was also a decline in the scores of both classes for the achieving approach over the two years, but only in the ALP class was this decline found to be statistically significant.

Self-Regulated Learning

In order to examine evidence of self-regulated learning (SRL) within the GTSP multiple sources of qualitative data were utilised. Participant observation and artefacts provided evidence of self-regulated learning in situ. In the following section, evidence from participant observations is discussed first. The evidence is discussed using Zimmerman's categories of SRL strategy (Zimmerman, 1989b) (see Appendix I). Following this, evidence from one-on-one interviews is discussed. The sampling method for one-on-one interviews is reviewed below (also see Chapter 3). Prior to discussion of findings for each interview, analysis across the sample of 11 interviews is discussed using the learning approach of the students as a point of reference.

Comparative data are available for the original LPQ by age and sex to allow a student's preference to a particular learning approach to be categorised. Consequently results from the Term 1 Year 8 LPQ, Term 3 Year 8 LPQ and Term 1 Year 9 cLPQ surveys were used to guide the Researcher in a process of purposeful criterion sampling (Patton, 2002; Stake, 2000) to select students with distinctive learning approaches for in-depth interviews which occurred in Term 1 2007 (see Chapter 3). One other student of interest was selected for interview whose results by LPQ survey indicated they fell close to the category of a low achiever (Biggs, 1987b). Thus, 14 students were selected for in-depth interviews, of these, three students declined to be interviewed. The breakdown of the learning approaches of the final 11 interviewees is shown in Table 5.3. As can be seen the students interviewed had a range of learning approaches as identified by the LPQ. The number of students interviewed represented 38% of the total number of GTSP students subject to participant observation.

Table 5.3

Breakdown of the Learning Approach of Interviewees

	Learning Approach				
	Surface (SA)	Achieving (AA)	Deep (DA)	Deep/ Achieving (DAA)	Low Achieving (LA)
Number of students	3	4	1	2	1
Indentifying Code	Student 1 Student 2 Student 3	Student 4 Student 5 Student 7 Student 10	Student 6	Student 8 Student 9	Student 11

Participant Observation

At MHS students have four lessons of science a week. In the descriptions that follow, lessons are numbered according to the sequence of lessons that occurred in the term. The decision to conduct interviews during science lessons limited participant observation to 14 G&T science classes, each one hour long, over a period of a school term. Approximately eight science lessons in total were used to conduct two interviews with each of the 11 interviewees. The evidence of self-regulation by students noted during participant observation is discussed in the following section using themes which correspond directly to Zimmerman’s 14 categories of SRL strategy (Zimmerman, 1989b).

Environmental Structuring

In terms of self-regulation students chose how to structure their environment from the moment they entered the science classroom for the first time in 2007 (Lesson one, 1/2/07). The teacher indicated that the students could choose their seat, with the caveat that they were not allowed to sit in the same position as the year before, nor sit next to the same person. Students in general then kept to this seating arrangement over the course of the term. In certain situations students chose to work with different group members for cooperative learning activities or the teacher assigned the students to groups.

Seeking Information

Students can seek information from a number of sources. During one lesson (Lesson five, 8/2/07), the teacher set a homework question “what is it about the atomic structure of metals that makes them good conductors?” The students were then instructed to highlight keywords in the question. The teacher asked where students might locate sources of information to assist with answering the question. The subsequent discussion led to students indicating the following: text books, library, the internet and parents. Students used such resources to complete the homework task.

During the period of observation (Lesson 28, 22/3/07) the teacher devised a research assignment and used a jigsaw cooperative learning strategy to involve students in the research of energy sources. The lessons were structured around the completion of structured overviews using the internet. Students researched the advantages, disadvantages and technology associated with using a particular energy source to provide electricity. This task allowed for differentiated learning in that the students had complete control of the depth and extent of their research.

Seeking Social Assistance

In relation to help seeking behaviour, the teacher encouraged students to see her for assistance. The teacher used pretests to assist her to appropriately compact the curriculum, however she still encouraged individuals to seek assistance in recognition of the different needs of her students. During one occasion (Lesson one, 1/2/07), after a practical activity on static electricity, the teacher requested that students with any conceptual problems see her. One student promptly did this. The teacher gauged the student’s understanding by asking the student to explain what she had understood from the practical and asked her why certain things happened.

Students approached the teacher informally on a number of occasions during the period of participant observation. The students were also encouraged to communicate with the teacher out of class time by Email. During a period of review, prior to the common assessment task (CAT) (Lesson 18, 2/3/07), several students asked the Researcher for assistance during a period of participant observation.

When students were working on energy resources, using a jigsaw cooperative learning strategy, the students were observed seeking assistance from knowledgeable peers. In particular one student helped another with the concept of how photovoltaic cells can provide electricity (Lesson 28, 22/3/07).

Organising and Transforming

All teachers at Metropolitan High School, including the G&T classroom teacher, participated in several professional learning days on the use of cognitive organisers in 2004, three years prior to the implementation of this research. One of the professional learning days was conducted by the Researcher. The G&T classroom teacher was a strong advocate of self-regulated learning and the use of cognitive organisers and provided some of the background materials on which the professional development was based. The G&T classroom teacher and the Researcher worked as critical friends, regularly discussing curriculum planning and developing resources for specific lessons. This close working relationship developed over a period of seven years.

Cognitive organisers are visual tools that assist learners represent facts, ideas, concepts and the connections between them; examples of cognitive organisers are: concept maps, mind maps and graphic organisers. Examples of organisers modelled in the professional development sessions included: strengths, weaknesses, opportunities, threats (SWOT); pros, cons, questions (PCQ); plus, minus, interesting (PMI); the balance, T charts and fishbone diagrams (Bellanca, 1992; Bennett & Rolheiser, 2006; Frangenheim, 2002). SWOT analysis is used to analyse a proposal or practice. It provides a structure to allow the strengths, weaknesses, opportunities and threats associated with a practice to be considered for an extended period of time. PCQ and

PMI are similar strategies used by students to analyse a situation before deciding if they support it. The benefits and disadvantages are listed first; then questions (in PCQ) or interesting points (in PMI) are displayed. The balance is used to analyse whether evidence is weighted towards or against a proposal. A T chart is applied in a learning situation where students are asked to focus on opposing characteristics of a concept. A fishbone provides an issue that is the focus of thinking, then students recall and organise ideas according to some kind of classification.

Within the Year 9 G&T science class, the students made extensive use of cognitive organisers introduced to them by their teacher. The choice of organiser was determined by the teacher on the basis of her pedagogical content knowledge (Loughran, Berry, & Mulhall, 2007); in other words, she selected from her repertoire of strategies the organiser most suited to the task at hand. During the period of observation, the following organisers were used by students in their learning: concept map, mind map, structured overview, fishbone and a spider diagram which the teacher referred to as the "Hairy Sheet".

When the teacher introduced and modelled a particular organiser for the first time she used familiar concepts and the students then used the organiser to structure material in the context of the lesson. For example, when the fishbone was first introduced (Lesson 14, 23/2/07) it was modelled around the teacher's dilemma of what to order for lunch: "sushi or a chicken and avocado sandwich?" Pros and cons were discussed with the class and a sample fishbone completed on the whiteboard by the teacher to assist with a decision. The students then utilised a fishbone to compare features of series and parallel circuits and to decide which type of circuit would be most suitable in the home. Thus modelling occurred in the zone of proximal development, with the intention that students would eventually learn to use the organisers autonomously as situations presented themselves (Roth, 1999; Vialle, Lysaght, & Verenikina, 2005).

Concept maps were used as a tool to develop conceptual understanding in science classes. For example: as a pretest on the concept of electricity (Lesson one, 1/2/07) the G&T science teacher instructed the students "to create a concept map and to use a pen to indicate things that you definitely know and a pencil to add things you think you know". In a subsequent lesson students were encouraged to modify their concept maps in light of the knowledge they had gained (Lesson two, 2/2/07). This task allowed each student to clarify their understandings and as such was an example of differentiated learning.

A spider diagram was introduced as a way of students structuring their understanding of electricity (Lesson six, 9/2/07). The teacher set this task for homework, but modelled completion of the organiser. Some characteristics of electricity were provided by question and answer. These were used to label some of "the legs" of the spider diagram. The teacher then directed that under each heading, the students use "the hairs" (on the legs) to put bullet points and summarise what they knew.

During the period of participant observation in the G&T science class, the Researcher noted those cognitive organisers that had been incorporated into lessons for student use. The Researcher also noted the educational purpose for these organisers (see Table 5.4). The organisers were used by all students either in class or for homework.

Table 5.4

Use of Cognitive Organisers in the G&T Science Class

Organiser used	Purpose
Concept map	To pretest students' prior knowledge of electricity
Spider diagram	To summarise ideas concerning current electricity
Fishbone	To compare series and parallel circuits
Structured overview	For note taking during research on renewable energy
T chart	To display the advantages and disadvantages of an energy source

Keeping Records and Monitoring

During the period of participant observation, prior to a section of content that was to be presented in lecture format, the teacher discussed a number of appropriate ways for students to take individualised notes (Lesson 12, 20/3/07). The students were then required to listen to "the lecture" and make notes in a way that suited them. The G&T students (n=29) used the following organisers: structured overview (n=8, 28%), concept map (n=3, 10%) and mind map (n=2, 7%). The majority of students made notes with no apparent structural organisation (n=16, 55%) see Table 5.5.

Table 5.5

Autonomous Use of Cognitive Organisers by Students for Note Taking Purposes

Type of structure	Number of students choosing this structure (n=29)
Structured overview	8
Concept map	3
Mind maps	2
Notes with no apparent structure	16

Results tables are widely used in science experiments to document observations, both qualitative and quantitative. Tabulation is a skill introduced in Year 8 science. On several occasions during Year 9 G&T classes, the students were asked specifically to focus on documenting the results of their experiments and to organise them through tabulation, but tabulation skills were not explicitly modelled (Lesson five, 8/2/2007 and Lesson 13, 22/2/2007). Consequently, during practical activities G&T students experienced a degree of autonomy and were free to set up such tables as they saw fit. Specific improvements to a student's work were discussed by the teacher and student on a one-to-one basis (e.g. Lesson five, 8/2/07).

Self-Evaluating

On occasions, the students were asked to think about their use of cognitive organisers using metacognitive reflection sheets. These sheets required students to reflect on the thinking they had engaged in, in order to complete an organiser and explain what was good about their thinking. Such a reflection tool was used after a spider diagram had been completed about electricity (Lesson six, 9/2/07). The students were directed to use a sheet called “1-Minute Paper Worksheet: A Thinking-Centred Self-Assessment Tool”. The directions instructed students to; take a moment to think about the thinking you just did and answer the following questions:

1. What new ideas, questions, insights, puzzles, or connections do you have?
2. What was good about the thinking that you did?
3. What could have been better? Explain. What will you do next time to improve your thinking?

The metacognitive reflection sheet provided a window into students’ understanding of the usefulness of the spider diagram as an organiser. It was apparent that students of different learning approaches went about filling in the spider sheet in different ways. Surface learners focussed on definitions of key terms, units of measurement and measuring instruments (Student 1, Surface Approach), whereas deep learners extended their ideas to interrelationships for example Ohm’s law connecting current, resistance and voltage and calculations of power (Student 8, Deep/Achieving Approach). “The part that puzzled me was the measuring of electrical flow or current. I thought of some new ideas and realised that electricity is a vast subject that leads to new ideas and areas” (Student 9, Deep/Achieving Approach). “There are not many new ideas, questions, insights, puzzles and connections that I have or think of about electricity” (Student 2, Surface Approach).

During a review of series and parallel circuits using abstract, problem solving questions, students were encouraged to reflect on any conceptual problems they were encountering (Lesson 12, 20/2/07). Equipment was provided, in a subsequent lesson, so that students could construct the circuits on the question sheet to assist with the task (Lesson 13, 22/2/07).

Concept maps were used by students to evaluate their conceptual understanding in science. Initially students created a concept map about electricity and used pen to indicate things that they definitely knew and a pencil to add things they were a little unsure of (Lesson one, 1/02/07). This involved the students evaluating the status of their conceptual understanding. The students then carried out a number of activities relating to static electricity. For homework, the students were asked to modify their concept maps in light of the knowledge they had gained.

Reviewing Records

In the week preceding the CAT (Lesson 16, 27/2/07) students were asked to review their past learning by developing a quiz board that required construction of an electrical circuit which would light up when a correct answer was selected by contestants. To extend this task and elicit higher order thinking, the teacher discussed with the class how to develop questions at the various levels of Bloom's taxonomy, for example she described synthesis level questions as "the ones that will give us crunchy eyebrows and will require you to think". She provided a summary sheet to assist students to apply Bloom's taxonomy to the task. Groups of three were allocated randomly. Students had to review their notes and textbook in order to construct the questions, devise answers and to make the circuit board. Each group completed the task with a product that was a composite of the ideas of the group. Although an emphasis had been placed on higher order questions, most groups limited their questions to those at a knowledge and comprehension level. In order to determine the degree of thinking the group expected each question to evoke, the suggested answer was taken into consideration by the Researcher. For example one group (Group 1) asked "what is the difference between a series and parallel circuit?" their suggested answer was "each globe can glow when others in the circuit aren't" this implies that the group expected a response at the knowledge level rather than analytical level.

The total number of questions set by students was 66, of these three were at the evaluation level (4.5%), one was at analysis level (1.5%), seven were application level (10.5%), 16 were at the comprehension level (24%) and the remaining 39 questions were knowledge level questions (66%) see Table 5.6.

Table 5.6

Levels of Questions Constructed by Students for an Electricity Quiz Board

	Level of question as determined by Bloom's taxonomy					
Group Number	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
1	5	1				
2	5	1	1	1		
3	3	1	2			
4	2	4	1			1
5	6	1				
6	2	2	2			2
7	Artefact missing, knowledge questions observed Lesson 16, 27/2/07					
8	7	3	1			
9	9	3				

Finding 5.2

There was evidence that the teacher of the G&T class was putting in place strategies to assist students to develop self-regulation. After pretesting and compacting the curriculum, the teacher encouraged help-seeking behaviours. The classroom was a safe environment in which the students felt at ease to seek assistance from the teacher. The students were involved in differentiated learning tasks where they had a degree of autonomy. In everyday tasks, the students had complete autonomy in the way they structured the recording of data. To assist the organisation and transformation of data the teacher focussed on the use of cognitive organisers. The teacher also directed the students to reflect on their learning processes and involved the students in strategies to assist metacognition.

Student Interviews

The 11 selected gifted and talented students (Table 5.3) were interviewed on a one-on-one basis on two separate occasions (see Figure 5.1)**.** Interview A focused on the students' preparation and use of cognitive organisers for a recently completed, compulsory assessment task (CAT) that was administered to all Metropolitan High School Year 9 students including students in the GTSP. Interview B focused on how students would approach a hypothetical assessment task that was designed to be quite different from the common assessment task in that it was open-ended and authentic. Specifically, Interview B probed the students' use of cognitive organisers under the task conditions of the hypothetical assessment.

Pilot interviews were conducted with two students prior to both Interview A and Interview B to ensure confidence in the interview process. As an experienced teacher and year coordinator, the Researcher had experience in questioning and interviewing techniques, thus little modification of the interview protocol was deemed necessary. All interviews were tape-recorded and subsequently transcribed. Data were reviewed and analyzed with respect to Zimmerman's 14 categories of SRL strategy to describe and explain the use of cognitive organisers as a self-regulated learning strategy under the various task conditions. Data analysis involved the examination of data from the two interviews in relation to the learning approaches of the students interviewed (deep, achieving, deep/achieving or surface approaches).

<table>
<tr><th colspan="11">Week of Term 1 2007</th></tr>
<tr><td rowspan="2">Interview</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5"></td><td colspan="2">Interview A
Common
Assessment
Task</td><td></td><td colspan="2">Interview B
Hypothetical
Authentic
Task</td></tr>
</table>

Figure 5.1. Timeline for interviews

Interview A: Common Assessment Task

All students in the Year 9 cohort at Metropolitan High School completed the 30-minute common assessment task under test conditions in Week 6 of the school term. The common assessment task was an in-class test based on the first five weeks of the Year 9 MHS science program on energy and electricity. The test consisted of nine short answer questions that were marked out of a total of 28. Interview A commenced as soon as was feasible after the common assessment task in order to assist students to accurately recall their preparation for the task. To minimise disruption to other classes, interviews were only conducted during science lessons, thus interviews took place over a period of about two weeks.

Interview A commenced with an open-ended question regarding the student's preparation for the common assessment task. A semi-structured interview protocol was used to further probe the students' use of cognitive organisers in their CAT preparation (Appendix I). The effectiveness of various cognitive organisers presented in class was also discussed in relation to student preparation for, and successful completion of, the assessment task. Data obtained during classroom observations were used to prompt student recall. As the interview proceeded the interviewer asked more specific questions relating to each category of self-regulated learning strategy (Zimmerman, 1989b) to ascertain the extent to which the student had used such strategies in their CAT preparation. The duration of each in-depth interview was approximately 30 minutes.

Environmental structuring.

Nearly every student interviewed had an area at home for study where they went to do schoolwork as required. In general these areas were free from distractions and students chose not to play music when studying. In general they purposely structured their area so there were minimal distractions from outside sources. Interestingly a couple of students mentioned the need to study in a place where there were other people and small distractions; they felt it was difficult to concentrate in silence. One student chose a place to study that was more aesthetically pleasing over absence of distractions. She would listen to the radio if she felt her revision was going well.

Seeking information.

Students sought information most commonly from their textbook. Some went to the internet for additional information such as definitions for words not in the textbook. One student understood the value of the internet to find additional information, but did not use it to revise. One student accessed books through the local library.

Seeking social assistance peers, teachers, adults.

The students chose to seek advice from peers, teachers, siblings and adults such as parents and grandparents. A number of students got together with classmates close to the CAT, generally the day before, or even on the day of the CAT, and asked each other questions. Students chose to seek assistance form those that they perceived to be good at science based on previous test scores. Other students discussed what they thought would be included on the CAT so they could focus their revision. One student (Deep/Achieving Approach) mentioned discussing interesting concepts with peers rather than seeking assistance from them.

Organising and transforming.

The majority of students made notes using their textbook. The relevant chapters had been listed by the teacher. In general these note sheets consisted of a chapter heading from the text and associated dot points. The majority of students deliberately chose not to structure notes in the form of a concept map, even though they had started such a map in class and revisited it. Many appeared to prefer the linear nature of notes made using key points. One student (Deep/Achieving Approach) made mention of combining cross curricular links on his linear notes. Another student (Deep/Achieving Approach) liked mind maps for organising their ideas. This student had added to the concept map started in class to extend her understanding of the topic.

The use of cognitive organisers to prepare for the common assessment task.

The interview transcripts revealed that in preparation for the common assessment task the students made use of cognitive organisers for various purposes including revision, review and recall of information as indicated in Table 5.7 (Tan, Dawson, & Venville, 2008). For most of the students (eight of the 11 interviewed), preparation for the common assessment task involved reliance on their textbook and making notes in the form of a structured overview using the chapter headings from their textbook as organising themes. Few students reviewed any organiser constructed prior to the common assessment task. During the interviews, organisers constructed during the term were spontaneously mentioned by students on five occasions. Two students indicated that the fishbone used in class activities assisted their recall during the common assessment task.

Table 5.7

Student Use of Cognitive Organisers in Preparation for a Common Assessment Task

		Number of students choosing the structure, organised by learning approach of students			
Cognitive organiser	Purpose	Surface (SA) (n=3)	Achieving (AA) (n=4)	Deep (DA) (n=1)	Deep/Achieving (DAA) (n=2)
Structured overview	Revision notes	2	3	1	2
Concept map	Review of information	0	0	0	1
Spider diagram	Review of information	0	1	0	1
Fishbone	Review of information	0	1	1	0
	To recall information	1	1	0	0

Students whose revision program for the common assessment task involved written notes chose to use structured overviews regardless of their learning approach.

Students had completed eight common assessment tasks the previous year, Year 8, and understood that the content to be tested was to be based solely on their textbook. Thus most students relied exclusively on their textbook for information and limited their notes to what they thought would assist them in the forthcoming test. The students' structured overviews were, therefore, almost always based on the content of the science textbook and were generally organised around chapter headings. "I find that the teachers often base the test on the textbook . . . so it helps a lot to research in the textbook. . . . I tried to research on the internet once and I just got totally messed up" (Student 7, Achieving Approach). Even the students with a deep approach relied on the textbook for the structure of their notes.

Three students made no notes at all. Two of these students (Surface Approach, Achieving Approach), had no organised study timetable, so they did not make notes, but read through the textbook shortly before the common assessment task. Two of the same three students (Achieving Approach, Deep/Achieving Approach) made use of a revision sheet supplied by the teacher to target their revision reading. Only the two Deep/ Achieving learners read with the intention of adding to their personal constructs. One consciously chose to add information from his revision reading to the mind map in his brain rather than making notes. The other cross referenced information from multiple sources to build: "layers of brick wall, not just one small brick. If you put the internet and then the research that we did and then the experiments, it all adds up, it makes a really clear picture" (Student 9, Deep/Achieving Approach).

When revising, few students referred to any of the cognitive organisers they had produced during lessons. Those students who did refer to the organisers had a deep, achieving or deep/achieving approach. No students thought to add to the concept maps they had produced and edited in class time in the light of new knowledge. Lack of understanding, at the point when the concept map was drawn, prompted one student (Achieving Approach) to do extra revision, although this student did not think to extend her map as a means of review. Most students were still at the stage where they needed to be cued to use concept maps in situations where they would be an effective learning tool.

> I haven't thought of going back, but if you said you'd better go back to your concept map and have a think about it then I'd probably go back. . . . I didn't

> actually go back, but if it was given to me now, for me to do again, I'd probably be able to write most of the things in pen because of the things I've learnt. (Student 10, Achieving Approach)

Concept maps were shunned by some students as an organiser. Indeed a number of students found them to be confusing rather than assisting them to streamline their thinking processes. "I find that it is more difficult for my brain to really picture that sort of set out, like a mind storm, I prefer having dot points and going down a list, linear rather than every which way" (Student 8, Deep/Achieving Approach).

Other students felt that you could not put enough detail on a concept map, indicating that these students equated knowledge with the acquisition of copious facts, rather than a holistic understanding of the interrelationships between concepts relating to a topic. However, those students who used concept maps understood their use to link ideas under a unifying theme. "If you make a concept map you can't write as much. Under dot points you can write as much as you want" (Student 8, Deep/Achieving Approach). "I think mind maps are really useful as they help you to organise your ideas" (Student 4, Achieving Approach).

The timeframe to create a concept map also appeared to be an issue. "When you create a concept map it takes ages, compared to just doing dot points . . . because you have to link the stuff together" (Student 6, Deep Approach).

The concept map was also being used in a fashion that was converse to that intended. Concept maps are a means of distilling salient information. One would think that deep learners would recognise the value in this strategy as a means of honing their understanding of a topic. Interestingly both of the students interviewed with a deep/achieving approach thought of concept maps as a tool for creating better linear notes. "Why make a mind map when you can have a mind map in your head that you can simply turn into dot points?" (Student 8, Deep/Achieving Approach).

During the common assessment task, the students were presented with a question concerning series and parallel circuits. Of the students interviewed, two stated that the fishbone assisted their recall of concepts although they had not used the organiser to revise. “That, [the fishbone], helped me get my ideas in order . . . but I didn’t study from it” (Student 6, Deep Approach).

Keeping records and monitoring.

The notes and worksheets that students used to prepare for the common assessment task included those that had been completed in lessons or for homework as directed by their class teacher. It was the students who, in addition, made their own notes to assist in their preparation for the CAT as discussed earlier that exhibited SRL in relation to keeping records and monitoring their learning.

Self-evaluating.

The revision questions supplied by the teacher made it possible for the students to evaluate their understanding of the concepts to be tested. One student worked harder as a result of realising they didn’t know much when attempting the concept map (Student 7, Achieving Approach). One student reviewed a section of work on Ohmic and non-Ohmic conductors after having difficulty answering a question on the CAT (Student 8, Deep/Achieving Approach). This student had revised by going through the revision questions and checking in the textbook for concepts they were unsure of, but had not gone further.

Goal-setting and planning.

Long term planning was not evident, even though students were accustomed to having a CAT mid-topic, after about five weeks work. Planning for the CAT was generally done in the week preceding the assessment and was initiated by the teacher indicating the date of the assessment for students to enter in their school diaries. In general the teacher warned the students a week in advance of an assessment. Students generally planned to review the topic, make notes and then revise from the notes. In some cases this review was done for a period of only 10-15 mins per evening, when the student had no other homework, and 30 mins each day of the long weekend when no other homework was set. A couple of students started their review two days prior to the CAT. One student (Surface Approach) did no review at all except for a short revision session during the recess break prior to the CAT.

The revision sheet provided by the teacher acted as a prompt to begin review and plan for the CAT. Generally the students who used the revision sheet satisfied themselves that they could answer the questions and only went to the text to look up things they did not recall. One student did the reverse, made notes, then looked at the revision sheet, then went back to the text.

One student (Deep/Achieving Approach) felt that studying "overly hard" made them agitated and therefore they underperformed on the assessment. This student's planning consisted of targeting the most difficult work first when they were still mentally alert.

Reviewing records: notes, tests, textbooks.

The majority of students revised using their textbook only. Some went back to their class notes and experimental write-ups for review. A couple of students used the revision questions supplied by the teacher to structure their revision. One student (Deep/Achieving Approach) reviewed records from various sources and noted that there were discrepancies between the information provided. Subsequently she merged the information from the multiple sources into a set of notes that she then used to revise.

Self-consequating.

Students rewarded themselves with free time when they felt they had completed a period of successful study. The feeling of self-efficacy was enough for some. One student rewarded himself with time to read. One student felt a good night's sleep after a period of intense revision was a just reward. In general a punishment consisted of spending extra study time. For some a poor mark in the CAT was a punishment for ineffectual study.

Rehearsing and memorising.

A few of the students memorised and rehearsed by getting together with peers for question and answer sessions or tested themselves. One student (Deep/Achieving Approach) rehearsed calculations by getting a selection from the internet based on Ohm's Law and working through them. A couple of students memorised their summary notes then got their parents to ask them questions. One Deep/Achiever disregarded memorising completely as it was contrary to his understanding of intelligence. He preferred to test his knowledge by practising problem solving which required the knowledge.

Learning behaviour initiated by others.

One student indicated that she made a study plan and stuck to it but only when the idea was initiated by the teacher, the teacher had instigated this practice the previous year for the semester examination. Another student obtained monetary rewards when she did well on assessments from her parents so this was a source of extrinsic motivation.

Summary

When preparing for a CAT at MHS all students regardless of learning approach relied heavily on the set science textbook. Most students minimised distractions whilst studying at their home. A common strategy was to make a summary in the form of linear notes structured around key definitions from the chapters covered in the text which were flagged by the teacher in the week prior to the test. Few students started any revision prior to prompting by their teacher, although the frequency of testing was similar every term from Year 8 onwards.

Surface learners displayed the least preparation for CATs. They relied heavily on guessing questions that might be included. Such students regularly sought help from others, particularly friends. Their study regime did not include rewards or punishments.

Achieving learners were more inclined to use the revision sheets provided by their teacher to target their revision. They relied on memorisation of key knowledge and enlisted the assistance of friends to test their recall. When learning material for the CAT they persisted in their memorisation until they were satisfied with their recall, as such a punishment for failure to learn the material was the extra time spent in revision. These students also relied heavily on concrete examples to help them understand concepts, such as role plays of electrical circuits.

Both Deep and Achieving learners explained that bad marks would be a form of punishment for not studying effectively.

Deep learners were more inclined to have a study area at home where they were able to interact with others as the need arose. In one case because his parents were knowledgeable the student purposely studied in a thoroughfare so that he could talk freely about concepts whilst studying. In another case the student liked to sit with a garden vista as her surroundings rather than a quieter area where there was no view at all.

It does appear that the most adaptive strategies were those employed by the Deep/Achieving learners. Their revision for the CATs was more extensive. Understanding came about by use of a strategic study plan that was designed to fill recognised gaps in their existing conceptual schema. Appropriate resources including knowledgeable others were targeted. Study generally involved the transformation of data from various reliable sources and practice of multiple examples of calculations where appropriate.

Finding 5.3

Students generally had a set place where they studied at home. Long term planning for the CAT was not evident in most cases. Planning was instigated after prompting by the teacher and distribution of revision sheets in the week prior to the CAT. In general, student preparation for the CAT was limited to notes in the form of a structured overview based on the content of the textbook, with little or no reference to any cognitive organisers used in prior lessons. Indeed students indicated a dislike for concept mapping. In the days preceding the CAT some students sought assistance and chose to test each other. Free time was the most common reward after a period of home study.

Consistent with what might be expected from the literature the depth of engagement in preparation for the CAT appeared to be related to the student's learning approach. Surface learners prepared in a very superficial manner aiming to memorise those sections of text related to the CAT. Achieving learners took advantage of revision materials provided by their teacher to refine their revision and provide themselves with the opportunity to practise type examples of questions they thought the task would contain. Deep learners were prepared to use multiple sources of reference to clarify any areas where they had identified a gap in their conceptual framework.

Interview B: Hypothetical Authentic Assessment Task

Interview B took place at the end of term in weeks nine and 10. To minimise disruption to other classes, interviews were only conducted during science lessons. Since the Researcher wanted to study the types of cognitive organisers used in the planning and completion of such tasks, it was necessary to produce a hypothetical, authentic task that could be used for the purpose of in-depth interview. The task developed had to stand alone and enable students to discuss organisers that they might use in relation to the task within the timeframe of a one-on-one interview lasting about 30 minutes. A copy of the task is included in Appendix J. The task was designed to be analogous to the open-ended, authentic, assessment tasks commonly used in the GTSP about once per term. It should be noted, however, that often these tasks involved group work over a number of weeks.

At the beginning of each interview, the student was given a copy of the task, a flier and a pamphlet and was allowed several minutes reading time. The flier surveyed student commitment to the use of renewable energy sources, rather than coal powered electricity. The pamphlet, from the company Synergy, explained how families could do something positive for the environment by electing to nominate that a set percentage of their energy usage should come from renewable resources. This commitment to green energy would increase their energy bill proportionately. The task required the students to develop an action plan leading them to a discussion with their parents with the focus of switching the electricity supply of the household to green energy. The discussion at the dinner table was the last phase of the task.

During Interview B, students were encouraged to 'think aloud' (Anders Ericsson & Simon, 1993) and outline the planning processes they would adopt to successfully complete the task. Part of the task requirement was for the student to produce something written to take to the target audience, the students' parents, for the purpose of discussion. As the interview proceeded the students were asked to draft the written work so the Researcher could observe whether it was modelled on any cognitive organiser known to the Researcher. Students were advised that detail was not required since they had not had exposure to the content surrounding the task.

In preparation for the interview, the Researcher had selected several common cognitive organisers aligned to the organisation and transformation of information processes required for the successful completion of the task. On completion of their written draft, each student was shown this range of cognitive organisers and asked if they recognised any of them. Copies of a SWOT analysis, balance, PCQ and fishbone were tabled and the student was encouraged to discuss their familiarity with each strategy and how effective each might be in planning for the hypothetical task. Although the Researcher had not seen all of these organisers used in science lessons during the period of participant observation, the chosen organisers had been modelled to Metropolitan High School staff at professional learning sessions and discussions with the class teacher confirmed that the students had been exposed to the organisers during science at some time during the current or previous year.

Environmental structuring.

During Interview B, no student discussed anything that could be interpreted as environmental structuring in their planning for the authentic task.

Seeking information.

A pamphlet of background information from Synergy was provided to students to look through before they started to plan for the task. Some students needed prompting that it would be appropriate to read this material to assist with the task. A couple of students thought that this pamphlet alone contained as much information as was required to complete the task.

Since an element of persuasion was involved in the task, the information students felt they needed to source was based on what might be needed to persuade their parents to choose green energy rather than conventional sources for example the cost. Several students indicated that the required information could be obtained by a phone call to the company Synergy mentioned on the pamphlet. Some suggested further information would be required on emissions due to coal burning power plants.

Although one student (Surface Approach) suggested research using books, the internet was suggested as a source of information in the majority of cases. Of the students choosing research using the internet, several suggested a focused search using the search engine “Google” starting with the Synergy website mentioned on the pamphlet. These internet searches would be focused on: how to apply for green energy, the benefits of switching to green power and the reasons why people were switching. One student (Deep Achieving Approach) suggested accessing scientific articles from the internet concerning the greenhouse effect.

Other sources of information suggested included: emotive videos on global warming for parents to watch and other brochures to cross reference the validity of data in the pamphlet initially provided for the task.

Seeking social assistance.

Few students mentioned asking others for assistance. One student suggested he would ask friends to assist with predicting questions his parents might ask during the discussion phase. One student (Deep Achieving Approach) would have preliminary discussions with her parents on several occasions prior to completing the task, so that she might focus her research towards finding answers to those arguments her parents put forward.

Keeping records and monitoring.

After researching material to assist with the task, a number of students suggested making notes from the internet or from a video, creating a brainstorm of good and bad points, tabulating a collection of statistics about the effects of using conventional power and recording statistics about costs. Several students stated they would then make these resources accessible for their parents.

One student (Deep Approach) suggested collecting emotive pictures of the effects of greenhouse emissions on glaciers. Records of endorsements from famous people who had converted to green power were suggested in a number of cases.

Self-evaluating.

Only one student (Deep Achieving Approach) suggested they would evaluate their personal behaviour and alter it (e.g. ride their bike to school for a week) to influence her parents' perceptions about her commitment prior to the task.

Reviewing records.

Two students (Surface Approach) indicated that they would review the material in the pamphlet prior to working on the task.

Goal-setting and planning.

Plans were focused around the last phase of the task, the discussion which involved trying to persuade parents to nominate that a set percentage of their energy usage should come from green energy. Although one student (Deep Achieving Approach) would rely on spur of the moment ideas for counterarguments during the discussion phase of the task, several stated that they would need to get their arguments together before proceeding with this phase. Only one (Deep Achieving Approach) suggested that these arguments would need to be evidence based. Her plan therefore was to collect such evidence.

In order to plan effectively a number of students suggested they would talk with their parents first; either viewing material on the internet with them, or looking at pamphlets or discussing the topic to gauge their parents' interest.

Self-consequating.

There was no evidence of self-consequating behaviours discussed by students during these interviews.

Rehearsing and memorising.

A student with highly educated parents (Deep Achieving Approach) felt that rehearsal prior to discussion with parents would be fruitless as from past experience his parents were always able to think of an argument the student had not envisaged.

However, another rehearsed planned arguments after careful review of the negative aspects of converting to green Energy.

Organising and transforming.

During Interview B, students were asked to draft the written component that they would take to the discussion phase. The format of this written work was examined to assess whether it was based on any cognitive organiser known to the Researcher. Results are shown in Table 5.8 (Tan, Dawson, & Venville, 2008).

Table 5.8

Student Use of Cognitive Organisers for a Hypothetical Authentic Assessment Task

	Number of students			
Cognitive Organiser	Surface (SA) (n=3)	Achieving (AA) (n=4)	Deep (DA) (n=1)	Deep/Achieving (DAA) (n=2)
Structured overview	1	1	1	1
T Chart	0	1	0	0
PMI	0	1	0	0
Alternative structure	2	1	0	0
None deemed necessary	0	0	0	1

When asked to draft the written component for the hypothetical task, the most common organiser, used by four of the 10 students interviewed, was a structured overview (Table 5.8). These overviews were usually constructed using organising themes from the pamphlets provided as stimulus material for the task. In recognition of the aim of the task, one student (Achieving Approach) chose to use a PMI without prompting and another (Deep Approach) used a T chart of pros and cons (Table 5.8). Those students (Surface Approach, Achieving Approach) with an alternate structure for their written work based it on a pamphlet, which was the format of the reading material provided for the task (Table 5.8). Biggs describes a surface approach as a learning pathology that does not engage a task in the way it should be (Biggs & Moore, 1993), students with a surface approach to learning were, therefore, not expected to go beyond what they considered to be the essential elements of the task. In this hypothetical situation, surface learners did not plan to research beyond the material provided to them and duplicated the format of the pamphlet for their written work.

Learning behaviour initiated by others.

Once the students had completed their written draft, the Researcher provided copies of several specific alternative cognitive organisers which the Researcher deemed to be aligned with the task and students were asked if they recognised them. Results are displayed in Table 5.9 (Tan, Dawson, & Venville, 2008).

Table 5.9

Recognition of Cognitive Organisers by Year 9 Gifted and Talented Science Students

	Numbers of students			
Cognitive organiser	Surface (SA) (n=3)	Achieving (AA) (n=4)	Deep (DA) (n=1)	Deep/Achieving (DAA) (n=2)
Fishbone	3	3	1	2
Scale	0	0	0	0
SWOT	0	0	0	0
PMI/PCQ	2	2	1	1

Nine of the 11 interviewed students recognised the fishbone and recalled it being used in science classes (Table 5.9). Some students could explain how this organiser could be used for the task presented.

> The fishbone, you could put on one side the bad things about switching to renewable energy and on the other side you could put the good things and show them [the target audience] how the good things outweigh the bad things. (Student 5, Achieving Approach)

Few students, however, deemed this format to be better than either the structured overview or PMI for the task at hand. The problems stated for the fishbone were the limited amount of space to present information and possible confusion due to the format for the target audience, “Green house gases and earth friendly energy is a lot of work, so it’s hard to put such a lot [of information] in a small space” (Student 9, Deep/Achieving Approach).

Although the students had been exposed to the other organisers in science class, some in the year preceding the research (Year 8), students were less familiar with them. They did not recall using the SWOT or scale (Table 5.9). The six students who recalled the PMI or PCQ (pros: cons: questions organiser) (Table 5.9) recognised them from a number of different contexts, not always science. Students were asked to comment on whether the various organisers recognised would have been suitable for the written component or planning of the hypothetical task. Results are shown in Table 5.10. Although both the fishbone and PMI/PCQ were recognised by the students (Table 5.9), they evaluated the suitability of these organisers for the task differently. Seven of the 10 students thought the PCQ was suitable for the task compared with only four for the fishbone (Table 5.10). Some students explained they could appreciate how they could develop arguments for a discussion with parents using a PCQ.

The hypothetical task involved persuasive argument and students with a deep or deep/achieving approach had recognised the need to prepare counter arguments, to expected questions from their target audience, before being presented by the Researcher with the PCQ for comment. Most students conceded that using a PCQ (which is closely aligned to a PMI) would have been useful for the task at hand. Once shown the visual prompt, learners of all approaches could see its application (Table 5.10) (Tan, Dawson, & Venville, 2008). “The PMI . . . is structured, so that if they [target audience] come up with the cons, you can counteract with the pros” (Student 1, Surface Approach).

Table 5.10

Suitability of Specific Organisers for the Hypothetical Task as Perceived by Gifted and Talented Science Students

	Numbers of students assessing the organiser as suitable for the task			
Cognitive organiser	Surface (SA) (n=3)	Achieving (AA) (n=4)	Deep (DA) (n=1)	Deep/Achieving (DAA) (n=2)
Fishbone	1	2	0	1
PMI/PCQ	2	3	1	1

One student (Achieving Approach) drafted her written work along the lines of a PMI without prompting. This student was familiar with the use of PMI as she had been exposed to this strategy from primary school onwards and was therefore able to use it autonomously.

> If I had to take a piece of paper it would probably be like this (PMI) because it's easy to categorise things . . . I don't think I have used it this year... I used it quite a lot last year and in Year 8. First of all the teacher would tell you to do it. After a while, like last year, I was writing a book review, the teacher wouldn't say to draw this, but it was easier for me to say the good things and bad things when I did it. (Student 4, Achieving Approach)

After recognising the value of using a particular organiser for discussion, one student (Surface Approach) realised that further research would be necessary to complete the task when using such an organiser; one student (Achieving Approach) was prompted to connect benefits with relevant drawbacks of conversion to green energy to assist with counterarguments, one student (Achieving Approach) was prompted to predict possible questions that their parents might ask.

In response to recognising the need for counterargument, prompted by the interviewers probing questions, one student (Achieving Approach) decided that more research would be necessary for persuasive purposes.

Probing by the interviewer caused one student (Achieving Approach) to suggest borrowing a video on debating technique. The purpose of this was to see how a debater wins the audience over, the kind of statements they make and how to improve the credibility of statements.

Summary

Surface learners, when presented with the task, mainly opted to use the stimulus material to prepare a simple summary of facts on the pros of green energy. The summary closely resembled the format of the stimulus material in terms of tables and key information. A concern for the aesthetics of the document outweighed any emphasis on green energy per se.

Achieving learners were inclined to broaden their search for data to support conversion to green energy beyond the stimulus material. They were inclined to use the contact information as provided in the stimulus package, but also suggested video resources. They prepared for a discussion with the aim of focusing on the pros of green energy, whilst also researching the cons. They drafted document types that included: pamphlets, emotive pictures, T charts and in one case a PMI (plus minus interesting) organiser. There was no evidence of pre-empting counter-arguments to green energy by researching in depth. The students were prepared to argue their case at point of need.

Deep learners were proactive in suggesting that they would first canvass their parents' thoughts on green energy. This tactic would assist them to refine their research with the aim of countering any arguments their parents might pose. Deep learners were prepared to rehearse prior to discussion, one student suggesting that they would review strategies used by successful debaters.

Deep/achieving learners included the need to provide cross-referenced supporting evidence to justify claims and perhaps research scientists of note that were promoting green energy themselves. They were prepared for several cycles of discussion on the topic, at each stage prepared to research further until resolution was attained.

Finding 5.4

The variation in the way students of different learning approach responded to planning for the hypothetical authentic task appeared to be related to the way the students understood the nature of the task demands.

Surface learners realised they needed to persuade their parents to convert to green energy but did not see past researching the facts behind the one point of view. In seeking information to complete the task students with a surface approach suggested finding information to extend what was prompted by reading of the background information for the task. Achieving learners researched both sides of the argument but still tried to maximise their efforts by focusing on the pros of green energy. Deep learners suggested cross referencing the data provided to them with that from other sources. Some deep learners focussed on detail for a sustained argument for which more planning and rehearsal would be required. Deep learners were able to deconstruct the task demands and see that they would need to foreshadow any reluctance to change by preparing thoroughly for debate with their parents. The deep/achieving learners showed evidence of the strategies most likely to result in a positive result at the discussion stage. They suggested strategies that would arm them at the debating stage with both conviction and justification of their point of view. The results from Interview B indicated that although the deep learners could articulate the processes required for planning a reasoned argument and they had an organiser available to them in their repertoire suited to the task, they chose not to access it and use it. It appears that these students were not yet sufficiently familiar with specific organisers to be able to use them autonomously in a task situation where they would have facilitated the transformation of information.

Whilst it was expected that students would make use of cognitive organisers in drafting a document to take to the discussion phase, very few students, regardless of learning approach suggested anything more elaborate that a T chart. Exposure to a range of organisers during science classes had not translated into student autonomous use of these organisers.

Self-Efficacy of Learning

Self-efficacy is an intrapersonal variable that affects the translation of gifts into talents (Figure 2.4). The academic milieu of the GTSP affects students' feelings of self-efficacy (Sekowski, Siekanska, & Klinkosz, 2009) and their use of SRL strategies (Zimmerman & Martinez-Pons, 1990). To assess students' perceptions of their self-efficacy, one dimension from the Student Attitude and Efficacy Scales was used. The student self-efficacy measure was administered during Term 1 Year 8, Term 3 Year 8 (2006) and Term 4 Year 9 (2007).

Table 5.11

G&T Students' Scores on the Self-efficacy Measure Term 1 2006, Term 3 2006 and Term 4 2007

	Mean	N	Std. Dev.	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
Term1 Year 8	11.09	23	2.466	0.514	0.536	22	0.597
Term 3 Year 8	10.91	23	2.778	0.579			
Term 3 Year 8	10.91	23	2.778	0.579	-2.086	22	0.490
Term 4 Year 9	12.04	23	3.808	0.794			
Term 1 Year 8	11.09	23	2.466	0.514	-1.503	22	0.147
Term 4 Year 9	12.04	23	3.808	0.794			

Paired sample *t* tests were used to determine if there was any changes in mean for self-efficacy (n=23) in the G&T class during Year 8 and Year 9 see Table 5.11. The G&T students' feelings of self-efficacy in learning increased between Term 1 and Term 3 Year 8 although the difference in the means was not significant. However, by the time the students reached the end of Year 9, their feelings of self-efficacy had declined below their perceptions at the start of Year 8. However, the difference in the means between Year 8 Term 3 (10.91) when perceptions of efficacy were at their highest and Term 4

Year 9 (12.04) when efficacy perceptions were lowest was not significant as determined by a paired sample *t* test.

The results for the ALP class are given in Table 5.12. The trends seen for the ALP class are the reverse of the G&T students. Although none of the changes were statistically significant, the ALP students' perceptions of self-efficacy declined during Year 8 (from 13.33 to 13.67) then increased slightly by the end of Year 9 (13.47).

Table 5.12

ALP Students' Scores on the Self-efficacy Measure Term 1 2006, Term 3 2006 and Term 4 2007

	Mean	N	Std. Deviation	Std. Error Mean	*t*	*df*	Sig. (2-tailed)
Term1 Year 8	13.33	15	4.624	1.194	-2.17	14	0.832
Term 3 Year 8	13.67	15	5.178	1.337			
Term 3 Year 8	13.67	15	5.178	1.337	-2.71	14	0.790
Term 4 Year 9	13.47	15	4.051	1.046			
Term 1 Year 8	13.33	15	4.624	1.194	-0.102	14	0.920
Term 4 Year 9	13.47	15	4.051	1.046			

Finding 5.5

The academic self-efficacy of the students in the G&T class was greater than that of students in the ALP class throughout Year 8 and Year 9. There was no significant change to the perceptions of self-efficacy amongst students within the GTSP.

Summary of Findings

Table 5.13 summarises the impact of the experiences in the GTSP on students' learning approach, self-regulation and self-efficacy.

Table 5.13

Summary of the Findings Relating to the Impact of the GTSP

	Finding
5.1	The learning approach scores, as measured by LPQ survey, showed similar trends in both the G&T and ALP classes. The scores for surface approach showed a small and non-significant increase over the two year period while the scores for the deep approach showed a small and non-significant decline. There was a decline in the scores of both classes for the achieving approach over the two years, but only in the ALP class was this decline statistically significant.
5.2	There was evidence that the teacher of the G&T class was putting in place strategies to assist students to develop self-regulation. After pretesting and compacting the curriculum, the teacher encouraged help-seeking behaviours. The classroom was a safe environment in which the students felt at ease to seek assistance from the teacher. The students were involved in differentiated learning tasks where they had a degree of autonomy. In everyday tasks, the students had complete autonomy in the way they structured the recording of data. To assist the organisation and transformation of data the teacher focussed on the use of cognitive organisers. The teacher also directed the students to reflect on their learning processes and involved the students in strategies to assist metacognition.
5.3	Students generally had a set place where they studied at home. Long term planning for the CAT was not evident in most cases. Planning was instigated after prompting by the teacher and distribution of revision sheets in the week prior to the CAT. In general, student preparation for the CAT was limited to notes in the form of a structured overview based on the content of the textbook, with little or no reference to any cognitive organisers used in prior lessons. Indeed students indicated a dislike for concept mapping. In the days preceding the CAT some students sought assistance and chose to test each other. Free time was the most common reward after a period of home study. Consistent with what might be expected from the literature the depth of engagement in preparation for the CAT appeared to be related to the student's learning approach. Surface learners prepared in a very superficial manner aiming to memorise those sections of text related to the CAT. Achieving learners took advantage of revision materials provided by their teacher to refine their revision and provide themselves with the opportunity to practise type examples of questions they thought the task would contain. Deep learners were prepared to use multiple sources of reference to clarify any areas where they had identified a gap in their conceptual framework.
5.4	The variation in the way students of different learning approach responded to planning for the hypothetical authentic task appeared to be related to the way the students understood the nature of the task demands. Surface learners realised they needed to persuade their parents to convert to green energy but did not see past researching the facts behind the one point of view. In seeking information to complete the task students with a surface approach suggested finding information to extend what was prompted by reading of the background information for the task. Achieving learners researched both sides of the argument but still tried to maximise their efforts by focusing on the pros of green energy. Deep learners suggested cross referencing the data provided to them with that from other sources. Some deep learners focussed on detail for a sustained argument for which more planning and rehearsal would be required. Deep learners were able to deconstruct the task demands and see that they would need to foreshadow any reluctance to change by preparing thoroughly for debate with their parents. The deep/achieving learners showed evidence of the strategies most likely to result in a positive result at the discussion stage. They suggested strategies that would arm them at the debating stage with both conviction and justification of their point of view. The results from Interview B indicated that although the deep learners could articulate the processes required for planning a reasoned argument and they had an organiser available to them in their repertoire suited to the task, they chose not to access it and use it. It appears that these students were not yet sufficiently familiar with specific organisers to be able to use them autonomously in a task situation where they would have facilitated the transformation of information. Whilst it was expected that students would make use of cognitive organisers in drafting a document to take to the discussion phase, very few students, regardless of learning approach suggested anything more elaborate that a T chart. Exposure to a range of organisers during science classes had not translated into student autonomous use of these organisers.
5.5	The academic self-efficacy of the students in the G&T class was greater than that of students in the ALP class throughout Year 8 and Year 9. There was no significant change to the perceptions of self-efficacy amongst students within the GTSP.

CHAPTER 6

EVIDENCE OF ACHIEVEMENT

The role of educators is to provide enjoyable lessons which allow students to demonstrate achievement and to equip students with the strategies required to maximise their potential. The role of educational researchers is to discover how this can be accomplished by unearthing the precursors that are the foundation of academic success (Dweck, 1985; Jinks & Morgan, 1999). In order to evaluate the GTSP, it is necessary to look at the students' success in terms of academic achievement which is used as a measure of the translation of gifts into talents in Gagné's model (Gagné, 2006).

This chapter addresses Research Question 3 and describes the achievement of GTSP students on all of the measures of achievement to which they were exposed. All MHS students sat school-based assessments and Monitoring Standards in Education (MSE) Tests in Science and Mathematics. In addition GTSP students sit for a number of recognised science and mathematics tests designed for above average students such as the International Competitions and Assessments for Schools Science Competition.

Measures of Achievement

In this chapter the achievement of the GTSP students on international, national, state and finally school assessments are reported.

International Competitions and Assessments for Schools Science 2007

The International Competitions and Assessments for Schools (ICAS) Science Competition is conducted by the education assessment unit of the University of New South Wales. Students from seven countries sit the competition. Students in Year 9 sit the G standard paper. In 2007, 3097 students in WA sat the competition. All students in Year 9 GTSP at MHS were entered in the competition. Table 6.1 shows the MHS results compared to the performance of other students from the state. Table 6.2 breaks down the comparison further to include the areas of science assessed by the competition. Table 6.3 shows results of Year 9 MHS students by question.

Table 6.1

Results of Year 9 MHS Students on the ICAS Science Competition Compared to the State of Western Australia

	MHS	Western Australia
Number of questions	45	45
Participants (n)	57	3097
Highest score	44	44
Average score	35.3	28.2
Std. Dev	4.9	6.6

Table 6.2

Results of Year 9 MHS students on the ICAS Science Competition Compared to the State of Western Australia in Each of the Areas Assessed

	Observing Measuring (OM)	Interpreting (I)	Predicting Concluding (PC)	Investigating (Inv)	Reasoning Problem Solving (RPS)
Highest score	6	8	13	10	8
MHS Year 9 average score	4.4	7.5	10.8	7.0	5.6
WA Year 9 average score	3.3	6.7	9.2	5.4	3.5
Difference between MHS and WA average as a % of the state average	33	12	17	30	60

The average score on the ICAS Science Competition of GTSP students at MHS was about 20% higher than that of other students sitting the competition from Western Australia. GTSP students scored higher marks in all areas assessed, the most marked difference was in reasoning and problem solving where the MHS results were 60% above the state average. Noticeable differences were also seen in observing/measuring (33%) and investigating (30%). The breakdown of results by question showed areas of strength in 33 of the 45 questions as determined by the education assessment unit of the

University of New South Wales. The breakdown by question indicated no significant areas of weakness.

Table 6.3

Comparison of MHS students to the State of Western Australia on the ICAS

Difficult questions	Question number	Area assessed	MHS percentage correct	WA percentage correct	Strength/ weakness
	14	OM	21	17	
	36	Inv	37	19	S
	45	RPS	47	28	S
	43	RPS	58	29	S
	13	Inv	65	30	S
	41	RPS	53	33	S
	40	RPS	67	34	S
	30	RPS	89	34	S
	44	PC	53	36	S
	19	PC	84	41	S
	42	Inv	54	46	
	3	I	75	51	S
	39	Inv	63	52	S
	34	Inv	72	55	S
	25	PC	67	58	
	4	I	70	59	S
	37	Inv	68	59	
	31	RPS	79	62	S
	33	Inv	79	63	S
	29	RPS	79	64	S
	27	PC	81	65	S
	10	PC	91	65	S
	5	I	79	66	S
	1	I	98	67	S
	35	Inv	81	67	S
	9	PC	84	68	S
	28	RPS	89	69	S
	6	I	95	71	S
	8	PC	81	72	
	20	PC	79	73	
	32	Inv	91	73	S
	12	I	91	75	S
	15	I	88	76	S
	16	I	93	78	S
	24	PC	82	78	
	36	Inv	91	79	S
	23	PC	86	79	
	11	I	93	84	S
	7	I	98	85	S
	22	PC	95	86	S
	2	I	91	89	
	17	I	96	93	
	21	PC	98	94	
Easy questions	18	I	100	95	S
	26	PC	100	100	

S=strength W=weakness (as determined by the education assessment unit of the University of New South Wales).

Finding 6.1

Students in the GTSP achieved sound results in the ICAS Science Competition which is an internationally recognised assessment of science understandings composed entirely of multiple choice items. In particular, the students' problem solving, observing/measuring and investigating skills were markedly above the state average.

The Australian National Chemistry Quiz

The Australian National Chemistry Quiz is administered by The Royal Australian Chemical Institute and is sponsored by Charles Stuart University. In 2007 students from 17 countries and 1382 schools participated. The competition is open to students from Year 7 primary school to Year 12 secondary school. In 2007 11,300 Year 9 students from across the world took part. All students in the Year 9 GTSP and Year 10 GTSP at MHS were entered for the Junior Division of the competition. Tables 6.4 and 6.5 show the results of Year 9 and Year 10 MHS students on the Junior Division paper of the National Chemistry Quiz compared to the state. The inclusion of the Year 10 data allows analysis of the achievement of the Year 9 GTSP cohort against the Year 10 GTSP cohort on the same achievement measure.

Table 6.4

Results of Year 9 MHS Students on the Junior Division of the National Chemistry Quiz Compared to the State of Western Australia

	MHS	Western Australia
Participants Year 9 (n)	52	716
Average score	15.5	15

Table 6.5

Results of Year 10 MHS Students on the Junior Division of the National Chemistry Quiz Compared to the State of Western Australia

	MHS	Western Australia
Participants Year 10 (n)	54	1178
Average score	20.0	17.2

Table 6.6 shows the number of awards achieved by GTSP Year 9 students on the National Chemistry Quiz 2007. The awarding of certificates of merit was as follows: High Distinction, top 10% of students in the state, Distinction top 25% to top 10%, Credit top 40% to top 25%. A High Distinction Excellence Award is given for outstanding performance.

Table 6.6

Awards Achieved by GTSP Year 9 Students on the National Chemistry Quiz 2007

Award	Number of students achieving this award
High Distinction Excellence Award	1
High Distinction	10
Distinction	18
Credit	17
Participation	12

Students in the Year 9 GTSP at MHS achieved scores only marginally better than the state average (3.3% above the state average). Each year at MHS students study Natural and Processed Materials, a chemistry outcome, however, it should be noted that in Year 9 this outcome is taught in Term 3 after students sit the Chemistry Quiz. At the time of sitting the quiz the Year 9 students had been exposed to a single chemistry topic studied in Year 8. The Year 10 GTSP students achieved scores 16.3% above the state average. Year 10 students had studied three chemistry topics by the time they sat the quiz.

Table 6.7 shows the breakdown of results of Year 9 MHS students by question in comparison to the state of Western Australia. Three questions showed areas of strength and two showed areas of weakness for Year 9s as indicated by the Royal Australian Chemical Institute. Question 11 for example was identified as an area of weakness. The question required students to name one of the reactants in a chemical change given the products. The question related to acid carbonate reactions. This class of reaction is taught as part of the Year 9 syllabus in Term 3 at MHS. Individual students achieved excellent results. A High Distinction Excellence Award was awarded to one student who was in the 100th percentile in the state. This student was awarded a commemorative plaque by a representative of the Royal Australian Chemical Institute. Twenty nine of the students who sat the quiz (n=58) achieved results in the top 25% of the state.

Table 6.7

Results of Year 9 MHS Students by Question in Comparison to the State of Western Australia on the National Chemistry Quiz

	Question number	MHS percentage correct	WA percentage correct
Difficult questions	19	23	23
	24	31	27
	14	31	28
	27	31	30
	18	25	32
	10	42	32
	22W	19	33
	15	27	35
	24S	52	39
	28	37	39
	30S	52	40
	08	37	44
	23	46	46
	25	46	46
	17	58	47
	11S	62	47
	29	50	49
	01W	37	49
	03	42	53
	20	60	53
	16	62	54
	06	63	59
	02	52	61
	05	77	68
	13	71	70
	26	79	75
	12	81	78
	04	86	78
Easy questions	07	90	79
	09	88	85

S=strength W=weakness (as determined by the Royal Australian Chemical Institute)

Finding 6.2

Whilst some individuals in the Year 9 GTSP achieved outstanding results in the Australian National Chemistry Quiz, in general the scores of the GTSP students were only slightly above the state average. The timing of the quiz in relation to the sequence of topics taught in Year 9 MHS might explain the lower than expected achievement.

Australian Mathematics Competition for the Westpac Awards

Students in the GTSP are selected into their science and mathematics classes on the basis of their score in the mathematics component of the Higher Ability Selection Test (HAST). Therefore it is fitting to include student achievement in a widely recognised mathematics competition in these research findings. The Westpac Australian Mathematics Competition is an annual competition conducted by the Australian Mathematics Trust, of which the University of Canberra is a trustee. The competition attracts over 400 000 entries from nearly 4000 schools in more than 40 countries. In Australia, the competition is open to students from Year 3 primary school to Year 12 secondary school. Generally, participants have an interest in mathematics and achieve at a high level in class work.

When GTSP students begin high school in Year 8, all students in the G&T class for science will be in the top mathematics class. Students in the ALP science class will form the second mathematics class. However, by the time students are in Year 9 and Year 10, some students will have been moved between the mathematics classes or out of the top two classes as a result of their mathematics achievement. The top two mathematics classes (n=54) in Year 9 in 2007 contained 41 students from the GTSP.

In 2007, all MHS students from the top two mathematics classes in Year 9 and Year 10 were entered for the intermediate division of the competition. The intermediate division paper was comprised of questions testing: geometry, algebra, arithmetic, enumeration skills and problem solving. MHS received a detailed statistical report from the Australian Mathematics Trust which described the achievement of students who participated in the competition. Table 6.8 below shows the results for students sitting the intermediate division of the competition from MHS. Table 6.9 shows the results for participating students from Western Australia. Table 6.10 shows how the MHS Year 9 and Year 10 intermediate division results compared with those of the state in the different sections of the paper.

Students in the top two mathematics classes in Year 9 achieved results 33.3% above the state average. The Year 10 students in the top two mathematics classes achieved results 19.7% above the state average. Year 9 and Year 10 students sat tests in the same division (Intermediate). It appears that in mathematics the Year 9 students were a stronger group, in that they achieved better results than their Year 10 counterparts with one year less exposure to high school mathematics. Interestingly Year 9 students were again 60% above the state average in non-routine problem solving.

Table 6.8

MHS Statistics in the 2007 Australian Mathematics Competition

Year	Number of participants (n)	Mean	Std Dev	Prize	Total HDs	Total Ds	Total Cs
9	59	47.97	12.61	1	5	19	20
10	53	46.70	10.24	0	1	15	26

HD= High Distinction D= Distinction C= Credit

Table 6.9

WA Statistics and Cut off Scores for the Australian Mathematics Competition

Year	Number of participants (n)	Mean	Std Dev	Prize Cut-off	HD Cut-off	D Cut-off	C Cut-off
9	5,274	36.00	11.52	77	64	49	37
10	4,734	39.00	12.18	81	69	53	40

HD= High Distinction D= Distinction C= Credit

Finding 6.3

Students in the GTSP program were initially selected into both science and mathematics classes on the basis of their results on the HAST test. The majority of students in the top mathematics classes were also in the GTSP (n=41). The results of the

Table 6.10

MHS Year 9 and Year 10 Intermediate Division Results Compared with those of the State of Western Australia in the Different Sections of the Australian Mathematics Competition

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Results	2D Geometry with diagram	3D Geometry no diagram	3D Geometry with diagram	Algebra basic manipulations	Algebra routine problems	Arithmetic basic manipulations	Arithmetic routine problems	Enumeration skills	Geometry basic manipulations	Geometry routine problems	Problem solving non-routine	Problem solving routine	Ratio
State	31	20	49	47	38	92	59	3	68	33	10	36	29
MHS Year 9	42	27	64	61	54	99	74	10	82	50	16	42	46
MHS score as % above state ave.	35	35	32	30	42	8	25	233	21	52	60	17	59
MHS Year 10	40	23	57	81	55	99	78	5	76	57	14	38	55

Westpac Australian Mathematics Competition, a multiple choice test, indicated that students in the top mathematics classes in Year 9 2007 were operating 33% above the state average. Furthermore, only those with a high level of mathematics ability enter this competition, which indicates MHS students were operating 33% higher than this select group. The MHS students had significant strengths in problem solving. Thus it seems that the HAST has, at least, been a good indicator of future achievement in mathematics.

WA Monitoring Standards in Education (MSE) Science

All students in public schools in Western Australia sit a Monitoring Standards in Education (MSE) Science Test in Year 9. The MSE Science Test is based on all four science conceptual outcomes: Natural and Processed Materials, Life and Living, Earth and Beyond, and Energy and Change, it also tests achievement in the process outcome Investigating Scientifically. The test consists of predominantly multiple choice items with some questions that require a short answer response. Detailed information is made available to schools by the end of the academic year and school reports include individual student's results on the MSE. The following information is available to a class teacher at MHS following the MSE testing.

A STUDENT DISTRIBUTION which shows: WA (state) mean; school mean or selected subgroup mean; state percentiles; and percentage of students in the state percentile bands.

The PERFORMANCE PROFILE which shows: students' initials against the Outcome Statements/Progress Maps; students' initials against the WAMSE scale; and the continuum of skills and understandings assessed.

The INDIVIDUAL PROFILE which shows: the performance profile for an individual student and the pattern of correct and incorrect responses for that student.

Table 6.11 shows the performance of MHS students against the state (WA) in the Year 9 MSE Science Test 2007. Table 6.12 shows the extent to which students at MHS have achieved beyond the state average in science. The results of the students in the top two science classes were noticeably better than the state average. Results of the top science class (G&T) were 25.1% above the state average; the ALP class results were 19.9% above the state average. In science the MSE test does not contain questions above Level 5 on the Outcomes and Standards Framework (Education Department of Western Australia, 1998) so it does not discriminate well between students at the top end. A score of 548 on the MSE Science Test equated to demonstration of outcomes at Level 5.

Table 6.11

Results of Year 9 MHS Students in Comparison to the State of Western Australia on the Year 9 MSE Science Test 2007

Cohort	Mean Score Science WAMSE	% in top 25th percentile band	% in middle 50th percentile band	% in lowest 25th percentile band
State WA	482	25	50	25
MHS Year 9	520	44	47	10
G&T class	603	97	3	0
ALP class	578	86	14	0

Table 6.12

Percentage Differences between Average Results of Year 9 Students in WA and Students in Year 9 MHS, G&T Science and ALP Science Classes on the MSE Science Test

Group	Percentage difference in mean scores compared to Year 9 cohort in WA
Year 9 MHS	+ 7.9
Year 9 G&T	+25.1
Year 9 ALP	+19.9

WA Monitoring Standards in Education (MSE) Mathematics

All students in public schools in Western Australia 2007 sat a Monitoring Standards in Education (MSE) Mathematics Test in Year 9. The test is of similar composition to the MSE Science Test. Comparable information was available to teachers as provided for the MSE Science Test. Table 6.13 shows the performance of MHS students against the State (WA) in the Year 9 MSE Mathematics Test 2007. The scores of the top two mathematics classes (A and B) are also shown. Table 6.14 shows the extent to which students at MHS have achieved beyond the state average in mathematics.

Table 6.13

Results of Year 9 MHS Students in Comparison to the State of Western Australia on the Year 9 MSE Mathematics Test 2007

Cohort	Mean Score Mathematics WAMSE	% in top 25th percentile band	% in middle 50th percentile band	% in lowest 25th percentile band
State WA	536	25	50	25
MHS Year 9	589	51	38	11
A Class	722	100	0	0
B Class	669	100	0	0

Table 6.14

Percentage Differences between Average Results of Year 9 Students in WA and Students in Year 9 MHS, A and B Mathematics Classes on the MSE Mathematics Test

Group	Percentage difference in scores compared to Year 9 cohort in WA
Year 9 MHS	+ 9.9
Year 9 A Class	+34.7
Year 9 B Class	+24.8

The top mathematics class scored 34.7% above the state average, with the B class 24.8% above. It should be noted that not all students in the GTSP classes Year 9 were in the top two mathematics classes at the time of the MSE (n=9). In mathematics the MSE Test does not contain questions above Level 5 on the Outcomes and Standards Framework (Education Department of Western Australia, 1998) so like the Science Test it does not discriminate well between high achieving students. A score of 575 was required for a student to be reported as achieving outcomes at Level 5.

Finding 6.4

In WA, Year 9 achievement in science is reported to parents as a result of analysing results on the MSE Science Test. This test measures science achievement in all conceptual and process outcomes. The science achievement of students in the GTSP 2007 was 25.1% (G&T) and 19.9 % (ALP) above the state average. Achievement in mathematics was even more impressive with class means 34.7% (A class) and 24.8 % (B class) above the state average.

School Measures of Achievement

At the time of this research, for the purposes of reporting to parents, summative, common assessment tasks (CATs) in the form of pencil and paper tests were used to gauge MHS student achievement in science. When an assessment item for a CAT was constructed, the Outcomes and Standards Framework (Education Department of Western Australia, 1998) was used as a guide to ensure the task offered all students the opportunity to demonstrate understanding at the level at which they were operating. Any CAT constructed for Year 9 MHS science students tested science Levels 2 through 6. The achievement target in Year 9 Investigating Scientifically in WA was Level 4. At the time of this research, an algorithm issued by DET was used to convert a student’s levels in science to a grade for the student’s school report.

Each question on a CAT was designed to test a particular level of understanding. Each CAT generally included multiple choice and short answer items. Marks were awarded against each levelled question on a CAT. A weighting system was applied so that questions testing higher order thinking were allocated the most marks. Total marks were used to rank students in the year group. This ranking was then used by administrators to make decisions concerning the movement of students into and out of the GTSP.

In addition to sitting CATs, all Year 9 students were required to sit examinations twice a year at the end of Semester 1 and Semester 2. Each examination tested work from the whole semester. Each student's Semester report indicated the percentage score they achieved in the examination. The examination score was used with the results from the CATs to award a grade on reports. Table 6.15 shows the average percentage scores of the Year 9 cohort compared to students in the G&T class and ALP for Semester 1, Semester 2 and for the Semester examinations. Table 6.16 shows the percentage difference between the average scores of the G&T and ALP classes compared with the averages of the Year 9 cohort.

Table 6.15

Results of Year 9 MHS Students in Comparison to G&T and ALP Science Students in School-based Assessments

	Average scores (per cent)			
Group	Semester 1	Semester 1 Examination	Semester 2	Semester 2 Examination
Year 9 MHS	47.5 (n=350)	61.7 (n=350)	48.9 (n=353)	62.0 (n=347)
Year 9 G&T	66.1	85.4	75.5	78.7
Year 9 ALP	62.1	77.4	65.2	71.4

Table 6.16

Percentage Differences between Average Results of Year 9 Students at MHS and G&T and ALP Science Students in School-based Assessments

	Percentage difference in scores compared to MHS Year 9 cohort			
Group	Semester 1	Semester 1 Examination	Semester 2	Semester 2 Examination
Year 9 G&T	+39.2	+38.4	+54.4	+26.9
Year 9 ALP	+30.7	+25.2	+33.3	+15.2

Using the results of the MSE Science Test as a guide (see Table 6.12) one would expect the students in the G&T class to achieve results about 17% above the Year 9 MHS cohort and students in the ALP class might be expected to achieve scores about 12% above. Students in the G&T and ALP classes did indeed score average marks noticeably higher than the Year 9 cohort in Semester 1 and Semester 2 based on common assessment tasks. The common assessment tasks were written to enable students' responses to be leveled at Levels 2 through 6. This enabled a slightly more fine grained assessment for higher achieving students than the MSE that only tested to Level 5. This may be the reason for the greater difference in GTSP student scores compared to the cohort. For example, the Semester 2 CAT for Life and Living contained challenging questions on food webs, stomatal movements, photosynthesis and respiration. In Natural and Processed Materials assessments, the higher level questions involved completing word equations and balancing chemical equations. Many students in regular classes faired poorly on such higher level questions; some did not attempt them at all. The difference in scores for the GTSP classes compared to the cohort in examinations was not as pronounced. The ALP class particularly did not maintain such high scores in the examinations compared to other Year 9 students.

Finding 6.5

In order to achieve good science grades at MHS students need to recall factual content and apply their knowledge. The results of GTSP students compared to the Year 9 cohort in the CATs and MHS based examinations demonstrate that the GTSP is providing opportunities for students to learn the skills and knowledge they need to achieve at high levels. Higher than average scores ensured that students in the GTSP almost without exception achieved A grades on their school reports in all science outcomes.

In the following chapter the relationship between factors that might impact achievement on school, state and national measures of achievement are explored using the results of correlation analysis.

Summary of Findings

Table 6.17 indicates a summary of the findings relating to the achievement of GTSP students.

Table 6.17 A Summary of the Findings of the Achievement of GTSP students

	Finding
6.1	Students in the GTSP achieved sound results in the ICAS Science Competition which is an internationally recognised assessment of science understandings composed entirely of multiple choice items. In particular, the students' problem solving, observing/measuring and investigating skills were markedly above the state average.
6.2	Whilst some individuals in the Year 9 GTSP achieved outstanding results in the Australian National Chemistry Quiz, in general the scores of the GTSP students were only slightly above the state average. The timing of the quiz in relation to the sequence of topics taught in Year 9 MHS might explain lower than expected achievement.
6.3	Students in the GTSP program were initially selected into both science and mathematics classes on the basis of their results on the HAST test. The majority of students in the top mathematics classes were also in the GTSP (n=41). The results of the Westpac Australian Mathematics Competition, a multiple choice test, indicated that students in the top mathematics classes in Year 9 2007 were operating 33% above the state average. Furthermore, only those with a high level of mathematics ability enter this competition, which indicates that MHS students were operating 33% higher than this select group. The MHS students had significant strengths in problem solving. Thus it seems that the HAST has, at least, been a good indicator of future achievement in mathematics.
6.4	In WA, Year 9 achievement in science is reported to parents as a result of analysing results on the MSE Science Test. This test measures science achievement in all conceptual and process outcomes. The science achievement of students in the GTSP 2007 was 25.1% (G&T) and 19.9 % (ALP) above the state average. Achievement in mathematics was even more impressive with class means 34.7% (A class) and 24.8 % (B class) above the state average.
6.5	In order to achieve good science grades at MHS students need to recall factual content and apply their knowledge. The results of GTSP students compared to the Year 9 cohort in the CATs and MHS based examinations demonstrate that the GTSP is providing opportunities for students to learn the skills and knowledge they need to achieve at high levels. Higher than average scores ensured that students in the GTSP almost without exception achieved A grades on their school reports in all science outcomes.

CHAPTER 7

FACTORS AFFECTING ACHIEVEMENT

Measures of student achievement at school, state, national and international levels were examined in Chapter 6. At school and state levels, students in the GTSP classes achieved science results well above average compared to the MHS Year 9 cohort. GTSP student results in tests developed for an international audience that included problem solving questions were also examined. Results for the GTSP classes again indicated above average achievement despite the fact that these tests are designed specifically to challenge more able students.

What is the recipe for success, does it reside in the learning approach of the individual student? Is positive self-efficacy of learning indicative of high achievement? To answer these questions, correlation analyses were conducted using the SPSS statistical analysis program. In particular, analysis was conducted to examine the effect of each of the learning approaches on achievement. To determine the predictive validity of the HAST, correlation studies are described for the HAST against various achievement measures. Finally relationships between self-efficacy and the HAST, and self-efficacy and achievement are explored.

Relationship between Learning Approach and Achievement

Year 9 students in the GTSP sat a number of tests and examinations that were measures of their achievement in science. Tests and examinations included: MSH CATs and examinations, the WA Monitoring Standards in Education (MSE) Science Test, International Competitions and Assessments for Schools (ICAS) Science Competition and the Australian National Chemistry Quiz. GTSP students’ scores in all dimensions of the LPQ (SS, SM, DS, DM, AS and AM) (see Chapter 3) as at Term 4 Year 9 were used to check correlations between learning approach with the measures of achievement.

Correlation between the achievement measures and deep/achieving approach (obtained by adding the scores from the deep and achieving dimensions) was also examined.

Despite literature indicating the positive effect of a deep approach to learning, statistical analysis did not reveal any significant correlation between science achievement and a deep approach for the GTSP students. Furthermore, although Biggs (1988, p. 187) states that the composite of deep/achieving approaches is a characteristic of many high achievers, no statistically significant relationship was found between measures of achievement and deep/achieving approach scores.

Literature indicates the negative effect of a surface approach on achievement. Thus a low surface approach score was expected to be linked to higher achievement. Significant negative correlation values were found for surface strategy (SS) against all the measures of achievement detailed previously. Statistically significant negative correlations were found for a surface strategy (SS) against all measures of achievement, (MSE r= -0.334, $p < 0.05$; ICAS r= -0.397, $p < 0.01$; National Chemistry Quiz r= 0.430, $p < 0.05$; MHS r= -0.386, $p < 0.01$) (Table 7.1). Furthermore, statistically significant negative correlations were found for a surface motive (SM) against achievement in all but MHS school- based measures, (MSE r= -0.286, $p < 0.05$; ICAS r= -0.300, $p < 0.01$; National Chemistry Quiz r= 0.341, $p < 0.05$) (Table 7.2).

Table 7.1

Correlation between Surface Strategy Scores and Measures of Science Achievement

Measure of achievement	Correlation coefficient (r)	Probability value (*p*)
MSE	-0.334	0.05
ICAS	-0.397	0.01
National Chemistry Quiz	-0.430	0.05
MHS measures	-0.386	0.01

Table 7.2

Correlation between Surface Motive and Measures of Science Achievement

Measure of achievement	Correlation coefficient (r)	Probability value (p)
MSE	-0.286	0.05
ICAS	-0.300	0.01
National Chemistry Quiz	-0.341	0.05

In addition significant positive correlations were found between achieving strategy (MHS r= 0.268, p< 0.05) and achieving motive (MHS r= 0.295, p< 0.05) with MHS measures of science achievement.

Finding 7.1

No significant positive relationship was found between the science achievement of Year 9 GTSP students and a deep or deep/achieving approach to learning. However, a student's predilection to address a task with a surface approach negatively affected their science achievement. For example it can be predicted that a student with high surface motive and surface strategy scores generally will fare worse in measures of science achievement for example the high stakes MSE Science Test which is used as a measure of science achievement at WA state level. Significant negative relationships were found between all measures of achievement and surface strategy and between all but MHS based measures of achievement and surface motive. An achieving approach showed a significant positive impact on achievement only at MHS school level.

Relationship between HAST and Achievement in Science

Students selected for the GTSP on the basis of the HAST are the expected to be the top MHS students in relation to science potential. With about 32 students in each GTSP class, the students might well be expected to rank in the top 64 of all Year 9 students at MHS. However, many GTSP students fell markedly below the top 64 ranked students in school-based assessments (see Table 7.3). In Semester 1 for example, 23 of the GTSP students ranked at a position below 64. Furthermore, non-GTSP students were able to rank in the top 64, which suggests that the MHS assessments underlying the ranking process and the HAST are measuring different things. The HAST measuring potential and the MHS assessments measuring demonstrated achievement in the school context.

Table 7.3

GTSP Students' Rankings on MHS Measures of Science Achievement

Semester	Number of GTSP students ranked below 64 on semester mark (MHS students n=350)	Number of GTSP students ranked below 64 on examination mark (MHS students n=347)
1	23	20
2	21	31

A student's selection into the GTSP program at MHS is based on their potential in science as determined predominantly by their mathematics score on the Higher Ability Selection Test (HAST) administered by the Australian Council for Educational Research (ACER) (see Chapter 4). If the HAST has high predictive validity for high science achievement, one can expect correlation between the HAST mathematics scores used to pre-select the GTSP students and scores on MHS measures of science achievement. When correlations were examined statistically significant relationships were found between the HAST scores and students' averages on MHS science achievement measures (r= 0.433, $p < 0.01$) and the MSE results in science (r= 0.392, $p < 0.05$).

Finding 7.2

The HAST scores of students selected into the GTSP program in Year 8 do show a statistically significant correlation with Year 9 GTSP students' scores in both school and state level science testing which shows that the HAST is a useful selection test for placement into the GTSP.

Relationship between HAST and Achievement in Mathematics

Students selected into the GTSP in Year 8, based on their mathematics potential determined by the Higher Ability Selection Test (HAST), also enter the top two classes for mathematics. By Year 9 some movement of students into and out of mathematics classes has occurred by a process which is to some degree independent of the students' science class. Consequently some students in the top two mathematics classes had not sat the HAST selection test. If the HAST mathematics scores are a determinant of mathematics potential, one would expect correlation between the HAST scores and scores on measures of mathematics achievement such as the WA Monitoring Standards in Education (MSE) Mathematics Test and the Westpac Australian Mathematics Competition.

When correlations were examined no statistically significant relationship was found between the HAST scores and the MSE Mathematics Test, however there was correlation between the HAST scores and the results on the Westpac Australian Mathematics Competition ($r = 0.451$, $p < 0.05$).

Finding 7.3

Achievement in mathematics is reported to parents on the basis of results in the MSE Mathematics Test which all Year 9 students sit across the state. It appears that the HAST has low predictive validity for achievement in the MSE Mathematics Test. On the other hand, the HAST has high predictive validity for achievement on the Westpac Mathematics Competition which is widely recognised as a measure of mathematics ability.

Relationship between Learning Efficacy and Measures of Science Potential

One dimension from the Student Attitude and Efficacy Scales developed in conjunction with the Technology Rich Outcomes Focused Learning Environments (TROFLE) by Aldridge, Fraser and Fisher (2003) was used to assess students' perceptions of their self-efficacy. Literature indicates that gifted students are more accurate at gauging their efficacy than regular learners (Pajares, 1996) and that student giftedness is generally associated with high levels of academic self-efficacy (Hong & Aqui, 2004; Zimmerman & Martinez-Pons, 1990).

Based on the assumptions that the HAST is an appropriate indicator of giftedness in science and that gifted students are gauging their efficacy accurately, scores on the HAST and self-efficacy measure (Term 4 Year 9) were used to examine any relationship between the two. No statistically significant correlation between HAST scores and efficacy scores was found.

Finding 7.4

Results of this research do not support a relationship between giftedness and academic self-efficacy using the HAST as an indicator of giftedness in science.

Relationship between Learning Efficacy and Measures of Achievement

Students' self-efficacy beliefs affect their academic attainment (Bandura, 1997; Hong & Aqui, 2004; Pajares, 2002; Zimmerman & Martinez-Pons, 1990). Students with a high sense of efficacy are likely to choose more difficult tasks, expend greater effort, persist longer, apply appropriate problem solving strategies and have lower task anxiety than those with a low sense of efficacy (Pajares, 2002; Rueda & Dembo, 1995; Schunk, 1989).

Relationships between the students' scores in measures of achievement namely on: MSH CATs and examinations, the WA Monitoring Standards in Education (MSE) Science Test, International Competitions and Assessments for Schools (ICAS) Science Competition and the Australian National Chemistry Quiz were examined for correlation with GTSP student scores on a self-efficacy measure (Term 4 Year 9).

Analysis indicates a significant relationship between MHS results in science CATs and examinations and the self-efficacy of GTSP students (r= -0.468, $p < 0.01$), between state level MSE results (WAMSE) and efficacy (r= -0.491, $p < 0.01$) and between national level science competitions (ICAS) and efficacy (r= -0.392, $p < 0.05$). No correlation was found between efficacy and scores on the National Chemistry Quiz.

Finding 7.5

For those students who have been selected as having the most potential in science based on the HAST, the results of this research support a relationship between science achievement and academic self-efficacy. The nature of this relationship remains unclear it is not simply that of a cause and effect.

Table 7.4 shows a summary of the findings of Chapter 7 relating to the relationships between factors that affect achievement within the GTSP at MHS.

Table 7.4

Summary of the Findings: Relationships between Factors Affecting Achievement

	Finding
7.1	No significant positive relationship was found between the science achievement of Year 9 GTSP students and a deep or deep/achieving approach to learning. However, a student's predilection to address a task with a surface approach negatively affected their science achievement. For example it can be predicted that a student with high surface motive and surface strategy scores generally will fare worse in measures of science achievement for example the high stakes MSE Science Test which is used as a measure of science achievement at WA state level. Significant negative relationships were found between all measures of achievement and surface strategy and between all but MHS based measures of achievement and surface motive. An achieving approach showed a significant positive impact on achievement only at MHS school level.
7.2	The HAST scores of students selected into the GTSP program in Year 8 do show a statistically significant correlation with Year 9 GTSP students' scores in both school and state level science testing which shows that the HAST is a useful selection test for placement into the GTSP.
7.3	Achievement in mathematics is reported to parents on the basis of results in the MSE Mathematics Test which all Year 9 students sit across the state. It appears that the HAST has low predictive validity for achievement in the MSE Mathematics Test. On the other hand, the HAST has high predictive validity for achievement on the Westpac Mathematics Competition which is widely recognised as a measure of mathematics ability.
7.4	Results of this research do not support a relationship between giftedness and academic self-efficacy using the HAST as an indicator of giftedness in science.
7.5	For those students who have been selected as having the most potential in science based on the HAST, the results of this research support a relationship between science achievement and academic self-efficacy. The nature of this relationship remains unclear it is not simply that of a cause and effect.

The question of how a surface learning approach detrimentally affects achievement in science for individuals remains to be addressed. Marton (1988) notes a clear relationship between a students' approach to learning and learning outcomes as described in the SOLO taxonomy (Collis & Biggs, 1979). This question is explored through case studies of the achievement of four selected individuals with particular learning approaches in the following chapter.

CHAPTER 8

CASE STUDY

Throughout the literature there is evidence to suggest that students with a deep approach to learning engage with tasks in such a way that they can demonstrate levels of achievement superior to those students with a surface approach. Inculcating such a learning approach would thus serve GTSP students well, both during the time they are participating in the program and in further studies. Consequently, to determine the impact of the GTSP on student learning the Researcher chose to track students' learning approach over a two year period.

This research indicates a degree of stability in learning approach over a two year timeframe when using a science class within the GTSP as a unit of analysis (see Chapter 5). However, using the individual as the unit of analysis reveals much greater variation in learning approach over time. There is evidence in the literature to suggest that approach to learning is not stable and that changes in learning approach are the outcome of shifts in the student's perceptions of the learning situation (Biggs, 2003; Prosser & Trigwell, 1999; Ramsden, 2003; Schmeck, 1988). Chapter 4 described the students' perceptions of their learning environment in the GTSP, as measured by the revised Individualised Classroom Environment Questionnaire (rICEQ) (see Chapter 3).

To examine the impact of the GTSP on the individual, this chapter focuses on four students who studied science within the GTSP over the two year research period. For each of these four cases, all of the available quantitative data and qualitative data were examined, namely: survey responses, interview transcripts, field notes and artefacts. The four individuals were selected on the basis of their learning approach scores at the start of the academic year 2007 when the students were in Year 9.

The original Learning Process Questionnaire (LPQ) (Biggs, 1987a) failed to recognise the hierarchical nature of the learning approach dimensions beyond the elements of motive and congruent strategy. In particular within the surface motive dimension it failed to separate the two constructs *fear of failure* and *aim for qualification* and as a result the surface motive dimension was multidimensional (Biggs, 1987a; Kember, Biggs, & Leung, 2004) leading to only satisfactory internal consistency when alpha coefficients were determined (Biggs, 1987a). This was one of the reasons for the development of the R-LPQ-2F. The development of the revised LPQ (R-LPQ-2F) (Kember, Biggs, & Leung, 2004) acknowledged that each learning approach is hierarchical and encompasses elements of motive and congruent strategy. It is also acknowledged that each motive and strategy element is itself multidimensional, each element having two subscales (see Figure 8.1).

The development of the cLPQ by the Researcher merged the achieving dimension of the LPQ with the deep and surface dimensions of the R-LPQ-2F, with some revision of the language to accommodate the context of Australian secondary schools and more specifically MHS. Consequently analysis of students' cLPQ scores allowed the Researcher to delve a little deeper into what motivated the students to engage with tasks in a particular way in comparison with the depth of analysis that would have been possible using the original LPQ.

The constructs underpinning each of the surface and deep dimensions of the cLPQ can be seen in Figure 8.1. The surface motive dimension has two subcomponents *fear of failure* and *aim for qualification.* The surface strategy dimension has two subcomponents *memorisation* and *minimising scope of study.* The deep motive dimension is comprised of *intrinsic interest* and *commitment to work.* Finally the deep strategy dimension has two subcomponents *relating ideas* and *understanding.* Since the achieving approach was not part of the R-LPQ-2F no further classification of the achieving dimensions is included in Figure 8.1.

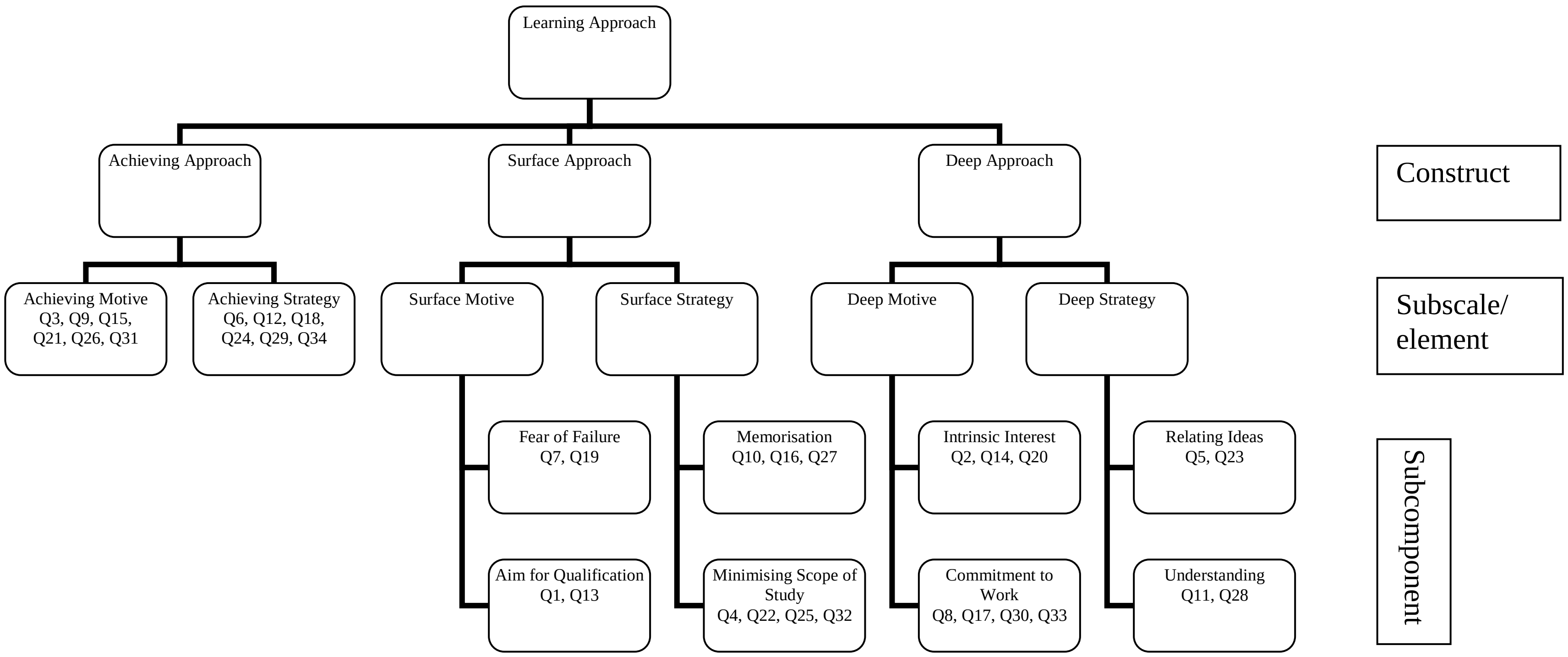

Figure 8.1. Hierarchy within the approach elements of the combined Learning Process Questionnaire (Kember, Biggs, & Leung, 2004)

The four individuals were selected for case study from the G&T class at the start of the academic year 2007 when the students were in Year 9. Two of the students, Matthew and Wade (pseudonyms), had the highest score amongst the students in the G&T class on the surface approach dimension of the Combined Learning Process Questionnaire (cLPQ) and two, Graham and Patricia (pseudonyms), had the lowest surface approach score on the same measure. There is no data in the literature to allow classification of student learning approach on the basis of student scores on the revised LPQ (D. Kember, personal communication, February 21, 2007) and hence the cLPQ. Ranking of students on the basis of their scores on the surface dimension, in conjunction with information from their prior results on the LPQ, enabled selection of students with the strongest positive predilection to surface learning and those with a negative predilection who were most strongly opposed to a surface approach. Prior to commencement of this research, the Researcher predicted that students with a low surface approach score would fare better in measures of achievement than those with a high surface approach score (see Chapter 7).

A further consideration in the selection of individuals for case study was their results on the Monitoring Standards in Education (MSE) Science Test. When results of the MSE Science Test for the students in the GTSP Year 9 G&T class were examined, Patricia and Wade were in the top eight, Graham was in the middle 16 and Matthew was in the bottom eight. When these students' MSE Science Test results were compared with students in the Metropolitan High School Year 9 cohort (n= 330) the students' rankings were Patricia (9), Wade (13), Graham (31) and Matthew (230). Table 8.1 shows the cLPQ scores and MSE Science Test results of each of the four students selected for case study.

The relationship between learning approach and demonstrated achievement in science for individuals is investigated in this chapter. Marton (1988) notes a clear relationship between a students' approach to learning and learning outcomes as described using the Structure of Observed Learning Outcome (SOLO) taxonomy (Collis & Biggs, 1979). In WA, the curriculum framework documents and the progress maps used to level students' achievement are based on the SOLO taxonomy. According to Marton (1988), students with a deep approach to learning are able to show evidence of relational and extended abstract learning outcomes that surface learners are not capable of. Marton states, that at best, surface learners are able to show evidence of multi-structural outcomes. Based on documents linking the outcomes of the SOLO taxonomy to levels embedded in the curriculum framework (Hackling, 2003) it would be expected that surface learners should not be able to show evidence of achievement greater than Level 4 in assessments. Consequently, work samples of selected GTSP students will be discussed in this chapter.

Table 8.1

Selection Criteria for the Four Cases

Student	Surface Approach score [a] on cLPQ Term 1 2007	MSE rank in G&T class (n=29)	MSE rank in MHS Year 9 cohort (n=330)
Patricia	25	7	9
Wade	40	9	13
Graham	22	17	31
Matthew	40	29	230

[a] Maximum score = 55

Case One Graham

Graham (previously identified as Student 8 in Chapter 5) originally began Year 8 in the Advanced Learning Program (ALP) class of the GTSP as his mathematics component score on the Higher Ability Selection Test (HAST) placed him below the cut-off for the G&T class with a score of 58. However his overall score on the HAST, at 174, placed him within the range of scores of other students in the Year 8 G&T class (rank 15/23). Graham's high scores in Year 8 science resulted in his promotion to the G&T class at the start of Year 9.

Table 8.2 shows Graham's scores on the LPQ at the beginning of Year 8 and the end of Year 9. It also indicates the classification of his learning approach based on the literature at both junctures (Biggs, 1987b). The difference in Graham's scores over the two year time frame is also noted. Graham's learning approach profile indicates a strongly negative predilection to surface motive and surface strategy which was maintained throughout the two year research period. Graham's positive predilection towards a deep/achieving approach strengthened over the two years in the GTSP. Note the increase in the deep motive dimension score by nine and an increase of 11 in the deep strategy dimension (Table 8.2), particularly of note when considering that the maximum score in each dimension of the LPQ is 30.

Table 8.2

Graham's Results on the LPQ

	Score on LPQ dimensions					
	Surface Motive	Surface Strategy	Deep Motive	Deep Strategy	Achieving Motive	Achieving Strategy
Term 1 2006 (x)	11	7	20	19	21	22
LPQ classification [a]	-	-	0	0	0	+
Term 4 2007 (y)	10	6	29	30	26	30
LPQ classification	-	-	+	+	+	+
Difference in LPQ scores (y-x)	-1	-1	9	11	5	8

Note. Maximum score = 30

[a] - negative predilection, + positive predilection, 0 no predilection

According to Biggs (1987b), Graham's profile at the end of Year 9 was that of an exclusive deep/achieving approach. In order to be categorised with a negative predilection, a student has to score in the bottom three deciles of those students' (age 14) scores analysed by Biggs (1987b) and to have a positive predilection a student has to score in the top three deciles. Of all the students tested in the GTSP Graham was one of only two students who were able to be classified by using Biggs' stringent method for classification at any time over the two year research period.

At the beginning of 2007 students in the gifted and talented class of the GTSP were assessed on the cLPQ. In 2007 Graham was in Year 9 and scored 22 on the surface approach dimension of the cLPQ (Table 8.3), this was the lowest score of students within the G&T class. The lowest possible score on this dimension of the cLPQ is 11; the highest possible score is 55. Table 8.3 and Figure 8.2, show Graham's results on the cLPQ in Term 1 2007 and Term 3 2007. Table 8.3 shows raw scores for each dimension and also scores as a percentage of the total possible for each dimension for the purpose of comparison since the number of items for each construct within a dimension varied. Figure 8.2 depicts the percentage scores for each dimension in graphical format.

Table 8.3

Graham's Results on the cLPQ 2007

	Score on cLPQ dimension					
	Surface Motive SM (20)	Surface Strategy SS (35)	Deep Motive DM (35)	Deep Strategy DS (20)	Achieving Motive AM (30)	Achieving Strategy AS (30)
Term 1 2007	14	8	28	20	24	26
% Scores (x)	70	23	80	100	80	87
Term 3 2007	12	11	30	20	27	25
% Scores (y)	60	31	86	100	90	83
Difference in % scores (y-x)	-10	8	6	0	10	-4

As a deep/achiever, it is noted from Table 8.3 and Figure 8.2, that Graham was increasing in both deep and achieving motive scores as time passed. Graham was also using congruent learning strategies, displaying a maximum score on each occasion for deep strategy use and also a high level of achieving strategy use. Graham's results on the cLPQ indicate a decline in surface motive; however, the data indicate an increased use of surface strategy over the same timeframe.

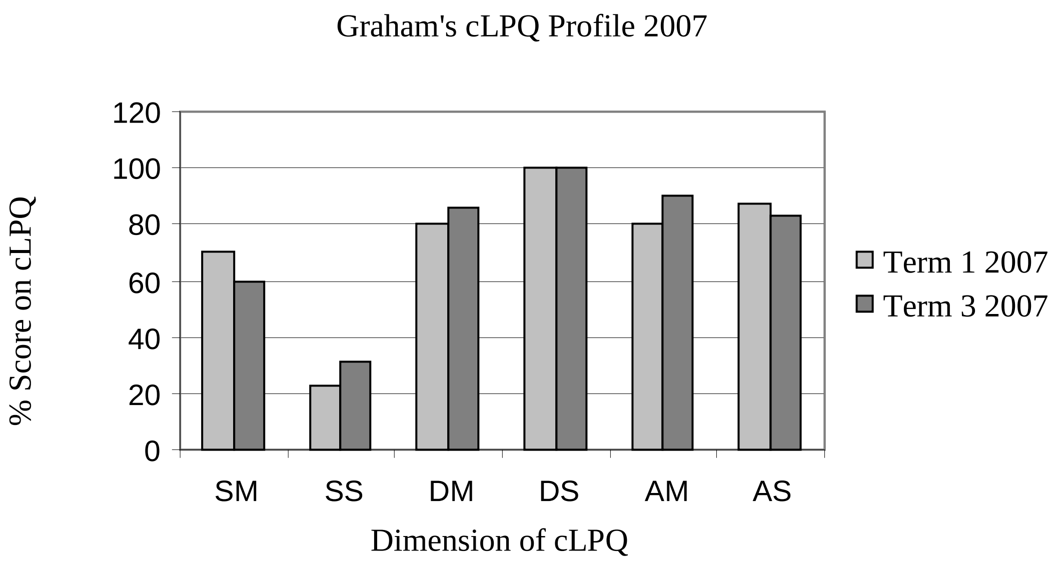

Figure 8.2. Graham’s results on the cLPQ 2007.

Further analysis of Graham’s score profile on the cLPQ (Term 1 and Term 3 2007) reveals the following information. Despite having a strongly negative profile with respect to surface approach with scores of 22/55 and 23/55 (Term1 and Term 3 2007), within the surface motive subscale Graham documented high scores on both questions relating to the *aim for qualification* subcomponent (Question 1, Whether I like it or not, I can see that doing well in school is a good way to get a well paid job and Question 13, I intend to study to Year 12 or beyond because I feel that I will then be able to get a better job). Figure 8.1 shows which questions on the cLPQ relate to each subcomponent.

Graham also recorded a high score on Question 25 (Term 3 2007) which related to the surface strategy subcomponent *minimising scope of study* (Question 25, I find that it is not helpful to study topics in depth. You really don’t need to know that much in order to get by in most topics). It appears that over time the value that Graham saw in studying topics thoroughly was diminishing as he could get by, presumably in assessment measures, with his base knowledge. Evidence of Graham’s concern over studying excessively for assessments was first apparent during an interview situation:

> I’ve found that if I study overly hard, I just can’t concentrate and I forget everything I’ve studied for ages and learnt in class normally and it just doesn’t help. If anything it puts me in a more agitated manner and I find it more difficult to do the test. (Interview, 13/3/07)

Graham later specifically included this statement on the back of his cLPQ survey (21/9/07) *"Study barely ever helps me but instead confuses me."*

Graham scored almost the maximum score possible on the cLPQ deep approach dimension (48/55 and 50/55). However, within the deep motive construct, *commitment to work*, Graham's response to Question 8 (Question 8: I come to most classes with questions in mind that I want answered) indicated that he only sometimes came to class prepared with a question that he wanted answered. Absence of questions brought to class may mean that the conceptual difficulty of the material taught in class was not challenging Graham. However, the absence of framing questions prior to class may have been because he had parents at home that were capable of answering any query in relation to science. It was because of this assistance that Graham structured his study environment to be in an open area adjacent to the family's lounge-room. In answer to a question at interview concerning the self-regulation strategy of seeking assistance, Graham responded:

> I'm quite lucky because every member of my family is quite adept in one or other topics. So whenever I have a question about biology that I don't understand quite, I go to my Dad who did biology as one of his favoured subjects. If I have questions in maths or physics I go to Mum or [my] brother. Basically I have a lot of help and information available at my fingertips. (Interview, 13/3/07)

Graham did not generally go to peers for assistance, but rather to discuss subjects of interest which is consistent with a deep learning motive. "Usually the assistance I get at home is adequate, but often I do discuss various topics with friends, basically just interesting points though and if one of us has trouble with that particular topic we will help each other" (Interview, 13/3/07).

On one occasion (Lesson 28, 22/3/07) Graham was observed assisting a fellow student having difficulty with the concept of photovoltaic cells. When studying Graham liked to relate new ideas to information he had already mastered and make cross curricular connections. "Pretty much everything, even to subject relations, I'll notice, like I will use maths to help understand the relation between two things in science" (Interview, 13/3/07).

Although in science classes Graham had been exposed to a number of cognitive organisers, he preferred to make linear notes and make connections between concepts in his head. “It’s easier to understand [connections] in your head because you have everything available to you instead of flipping through pages and things” (Interview, 13/3/07). “Why make a mind-map, when you can have a mind-map in your head that you can simply turn into dot points?” (Interview, 13/3/07).

Graham exhibited results consistent with those with a strongly positive achieving approach. Graham scored almost the maximum score on the cLPQ achieving approach dimension (50/60 and 52/60). However, in the achieving approach dimension (Question 15: I like the results of tests to be put up publicly so I can see by how much I beat some others in the class) Graham indicated he did not like results to be announced. In the achieving strategy dimension Graham indicated (Question 24: Soon after a class or lab, I re-read my notes to make sure I can read them and understand them) that he only sometimes re-read notes for understanding. In one interview (13/3/07), Graham described an instance when he went out from a test frustrated because there was a term with which he was unfamiliar (Ohmic). He immediately went to his textbook to look up the term. “As soon as I got in the car I got out the textbook and was looking through it . . . . it said in the textbook that things that changed their resistance were not Ohmic, full stop, that was the only sentence” (Interview 27/04/07).

For his study at home, Graham developed a strategy based on prioritising work purposely on level of difficulty, completing the most complex work first.

> A lot of people I know at school when given a lot of homework . . . . will do the easy stuff first, then the next easiest. Then they will have something on and won’t be able to get it [homework] finished that night and they will be stuck with the really hard stuff to do the following morning. (Interview, 13/3/07)
>
> The worst thing that ever happened to me with some homework, I accidentally left some and I was going through, as I went to bed, in my head, my homework and I realised that I had missed some. It was very easy stuff though. Although I was incredibly tired, exhausted after the previous hard homework, I found this was still quite easy to complete. (Interview, 13/3/07)

The Academic Efficacy Scale developed by Jinks and Morgan (1999) used for this research has seven items. The lowest score of seven indicates the highest perception of self-efficacy (see Appendix F). Throughout the two year research period, while Graham was in Year 8 then Year 9, his self-efficacy of learning score remained stable at seven. This indicates a strong positive feeling of self-efficacy in learning. Graham's responses indicate he feels that with effort he can master even the most difficult science concepts.

Graham had a view on intelligence and learning that went beyond rote learning to problem solving.

> I don't see it as intelligence if someone can remember the date that the light bulb was invented or something like that. . . . That's just knowledge. You do require knowledge for some things but basically your brain isn't just storage, it does actually think . . . . think something through . . . . like Thomas Edison. He didn't know if you put a bit of filament in a glass case and heat it up it will glow. He worked that out and that shows intelligence. (Interview, 13/3/07)

Table 8.4 shows Graham's results on the revised Individualised Classroom Environment Questionnaire (rICEQ) administered three times over the two year research period (Term 1 2006, Term 3 2006 and Term 4 2007). It also shows Graham's perception of the actual classroom environment (Term 3 2006). To facilitate analysis of changes to Graham's preferred classroom environment over time, the difference in scores between Term 1 2006 and Term 4 2007 are noted for each dimension. The maximum score on each dimension of the scale is 40.

Graham recorded consistently high scores for the *Personalisation* dimension, relating to teachers taking an interest in students, and for the *Participation* dimension throughout the research period (see Table 8.4). Over time Graham was showing increasing preference for *Independence* relating to student autonomy, *Investigation* and *Differentiation*. When Graham's perception of the actual classroom environment was surveyed in 2006 there was little difference between his perceptions of what was occurring in the science classroom and his preferred classroom environment at that time.

Table 8.4

Graham's rICEQ Results

	rICEQ scores				
	Personalisation	Participation	Independence	Investigation	Differentiation
Term 1 2006 Preferred (x)	38	39	28	34	23
Term 3 2006 Preferred	36	38	33	39	29
Term 3 2006 Actual	39	38	30	38	25
Term 4 2007 Preferred (y)	38	38	34	40	30
Difference in scores Preferred (y-x)	0	-1	6	6	7

Note. Maximum score = 40

Graham was a very able student but was not achieving as highly as others in Year 9 on school and state based testing (see Tables 8.5 and 8.6). With a science score on the MSE of 605, just above the class mean of 603, Graham was ranked 17th in the G&T class, his average level against the Outcomes and Standards Framework was Level 5. Of the 25 questions posed that required students to be operating at Level 5, Graham was able to demonstrate Level 5 outcomes on 13 responses. Demonstration of Level 5 outcomes is consistent with Marton's proposition (Marton, 1988) that deep learners should be able to show evidence of relational and extended abstract outcomes.

In order to demonstrate Level 5, a student would be operating at the abstract multistructural level of the SOLO taxonomy, being able to explain phenomena in terms of several simple abstract scientific concepts. Examples from the MSE Science Test 2007 to which Graham responded and demonstrated Level 5 outcomes include: using particle theory to explain why balloons expand in the sun, recognising and explaining why a chemical equation is unbalanced and explaining energy transfer in a greenhouse in scientific terms. Examples of school-based assessments where Graham demonstrated Level 5 outcomes were: a comparison of sediments expected at various positions along a river (Year 9 Earth and Beyond Common Assessment Task), a discussion of the processes involved as water molecules enter a plant and exit through the leaves (Year 9 Life and Living Common Assessment Task), interpretation of graphs showing factors limiting the rate of photosynthesis (Year 9 Semester 2 Examination) and interpretation of a figure showing a cross section of rocks using the laws of superposition and cross cutting (Year 9 Semester 1 Examination).

Table 8.5

Graham's School Results 2006 and 2007

	Rank			
MHS cohort	Semester 1	Semester 1 Examination	Semester 2	Semester 2 Examination
Year 8 2006 n = 343	3	Not applicable	3	Not applicable
Year 9 2007 n = 350	26	4	3	10

Table 8.6

Graham's School Levels of Achievement 2006 and 2007

	Science Outcome Level				
MHS cohort	Natural & Processed Materials	Life & Living	Investigating Scientifically	Energy & Change	Earth & Beyond
Year 8 2006	4	4	4	4	4
Year 9 2007	6	6	4/5	5	5

Whilst the MSE Science Test does not include examples of questions that allow demonstration of Level 6 outcomes, Graham was able to demonstrate Level 6 outcomes on MHS based science assessments. In order to demonstrate Level 6, a student would be operating at the abstract relational level of the SOLO taxonomy, being able to explain phenomena, using several simple abstract scientific concepts and the relationship between them. Examples of school-based assessments where Graham demonstrated Level 6 outcomes were: Interpretation of a food web to infer the effect of changes in one population on the population size of another organism in the same food web (Year 9 Semester 2 Examination), an explanation of the factors that will bring about stomatal movement at different times of the day and the effect that these movements will have on the survival of the plant (Year 9 Semester 2 Examination), an explanation of the steps required to transform a sample of metamorphic schist into a granite batholith weathering on the surface (Year 9 Earth and Beyond Common Assessment Task), interpretation of graphs showing the rates of photosynthesis and respiration in a plant throughout the day and compensation point (Year 9 Life and Living Common Assessment Task) and an application of Ohm’s law to calculate the current in a complex circuit with resistors in series and parallel (Year 9 Energy and Change Common Assessment Task).

During one class activity (Lesson 16, 27/2/07) students were working on questions for a quiz board to facilitate revision on electricity. Graham’s group devised a number of questions and answers which involved synthesis and evaluation levels of Bloom’s taxonomy, for example: “If you had to justify why a parallel circuit is better than a series circuit, which argument would you chose?” and “In what instance would a series circuit be more useful than a parallel one?” (Task: Making a quiz board, 27/2/07).

At MHS, science common assessment tasks for Year 8 students are constructed in such a way that students have an opportunity to demonstrate achievement of Level 5 outcomes. Interestingly, while in Year 8, with scores for deep learning approach in the mid range of percentiles (4-7), Graham was only demonstrating Level 4 on school-based assessments. Level 4 of the Outcomes and Standards Framework relates to operation at the abstract unistructural level of the SOLO taxonomy. At this level a student would show evidence of explaining effects that have been observed in terms of a single abstract concept that is non-observable, for example the student is able to explain energy transformations (abstract concept) in relation to an object rolling down a hill (observable effect). Nonetheless, in Year 8 Graham was still a high achiever in both the International Competitions and Assessments for Schools (ICAS) Science Competition and National Chemistry Quiz (Tables 8.6 and 8.7).

In the International Competitions and Assessments for Schools (ICAS) Science Competition 2007, Graham scored 42 out of 45. Feedback from the ICAS Science Competition from UNSW indicated Graham showed particular strength in investigating and problem solving. His performance in the areas of observing/measuring, interpreting and predicting/concluding were in the 90th percentile of the state. In the Australian Mathematics Competition for the Westpac awards 2007 Graham received a certificate of distinction.

In the National Chemistry Quiz 2007 Graham scored 27 out of 30. Interestingly, two of the three questions that Graham answered incorrectly were answered correctly by more than half of the entrants. The other question Graham answered incorrectly was the hardest question on the paper which only 23% of entrants got correct.

Table 8.7

Graham's Results on National Science Competitions 2006 and 2007

	Student rank as WA percentile	
National Science Test	2006	2007
International Competitions and Assessments for Schools (ICAS)	99	99
National Chemistry Quiz	>90	100
Australian Mathematics Competition for the Westpac awards	N/A	96

Summary

Graham was one of only two students who at some point in the research period could be classified according to Biggs as a deep/achiever. The literature suggests that the composite of deep/achieving is a characteristic of many high achievers (Biggs, 1988; Midgley, Kaplan, & Middleton, 2001; Pintrich & Garcia, 1991). Graham's deep approach scores increased over the two year research period, as did his levels of achievement as measured predominantly by MHS science assessment tasks.

Graham's definition of intelligence demonstrated an understanding of the need to assimilate information from multiple sources and to use knowledge for creative problem solving. Since Graham demonstrated Level 6 outcomes, in relation to the SOLO taxonomy he was operating at the abstract relational level and as such was able to explain phenomena using several abstract concepts and explain the relationship between them. He fulfilled the criteria on which his definition of intelligence was based. In state MSE science testing and national level testing, such as the ICAS and National Chemistry Quiz, Graham demonstrated high achievement in relation to his peers.

Graham maintained strong positive feelings of self-efficacy in learning and he felt that with effort he could master even the most difficult science concepts. His scores on the self-efficacy measure ranked him at the top of the G&T class in his perceptions of his self-efficacy at each time the measure was administered (rank 1/23 Term 1, 2006, rank 1/23 Term 3, 2006 and rank 1/23 Term 4, 2007). He prioritised his work based on the level of complexity, proceeding with the most complex tasks first. He then persisted until all of his work was completed, even getting up from sleep if he realised he had forgotten something (Interview, 13/3/07). Graham considered this to be a more adaptive strategy than that used by his peers, who he understood generally began the easiest work first, with the result that they lacked sufficient time to complete the more complex tasks adequately.

However, there was evidence that as a deep/achiever Graham was not using the full range of SRL strategies (Purdie, Hattie, & Douglas, 1996; Zimmerman, 1989b;

Zimmerman & Martinez-Pons, 1990). Graham preferred to rely on his ability to interconnect ideas in his head rather than commit the interrelationships to paper using any scaffold (Interview, 13/3/07).

The actual classroom environment in the GTSP closely matched Graham's preferred learning environment. This was likely because Graham's preferred classroom environment closely matched that of his teacher. It appears that the classroom environment of the GTSP facilitated the translation of Graham's gifts into demonstrations of talent.

Finding 8.1

Although Graham was not initially selected for the G&T class in Year 8, he demonstrated excellent levels of achievement throughout Year 8 and Year 9. Graham was a deep/achiever with a high perception of his self-efficacy. His confidence allowed him to assist others through peer teaching. Graham applied his deep motive for learning by utilising deep strategies that facilitated the expansion of his conceptual understanding. However, he was loath to commit his understanding of conceptual relationships to paper by way of strategies such as concept mapping. As a deep learner his perceptions of an ideal classroom environment matched those of his teacher.

Case Two Matthew

Matthew (previously identified as Student 2 in Chapter 5) was selected for the G&T class of the GTSP on entry to MHS in Year 8 and remained in the G&T class throughout Year 9. Matthew recorded an overall score on the Higher Ability Selection Test (HAST) of 158, this was the lowest overall score of those students selected for the Year 8 G&T class of the GTSP in 2006. However, Matthew's score of 60 on the mathematics component of the HAST (rank 11/23) placed him well within the range of mathematics scores of students selected for the Year 8 G&T class.

Table 8.8

Matthew's Results on the LPQ

	Score on LPQ dimension					
	Surface Motive	Surface Strategy	Deep Motive	Deep Strategy	Achieving Motive	Achieving Strategy
Term 1 2006 (x)	23	14	21	17	26	17
LPQ classification [a]	0	-	0	0	+	0
Term 3 2006	22	23	15	19	29	19
LPQ classification	0	+	-	0	+	0
Term 4 2007 (y)	22	19	18	25	21	20
LPQ classification	0	0	0	+	0	+
Difference in LPQ scores (y-x)	-1	4	-3	8	-5	3

Note. Maximum score = 30

[a] - negative predilection, + positive predilection, 0 no predilection

As can be seen in Table 8.8, Matthew's scores on the LPQ throughout the research period were not stable. Although differences in scores have been calculated between the start and end of the two year research period, given the variation in Matthew's scores in each dimension of the LPQ over time, the following section discusses changes between results from one LPQ survey to the next within the research period.

At the beginning of 2006, when Matthew was starting Year 8, he was scoring in the top three deciles of the LPQ for achieving motive compared to those students (age 14) whose scores were analysed by Biggs (1987b). His achieving motive score was the third highest score (rank 3/23) in the G&T class of the GTSP. Matthew's score on the surface strategy dimension was in the bottom three deciles at this time using Biggs' data. Matthew's surface strategy score was, however, in the midrange of students within the G&T class (rank 13/23) on this dimension of the LPQ.

Between Term 1 and Term 3 2006, the most noticeable changes in Matthew's LPQ scores were in the surface strategy and deep motive dimensions. By Term 3, Matthew was scoring in the top three deciles according to Biggs in the surface strategy dimension and had the second highest surface strategy score within the G&T class (rank 2/23). This increase in surface strategy use was not, however, accompanied by a corresponding increase in surface motive. Furthermore Matthew was scoring in the bottom three deciles on the deep motive dimension according to Biggs and had the lowest score of any student in the G&T class (rank 23/23). This decline in deep motive was not matched by a decline in deep strategy use as Matthew's use of deep strategy had increased marginally between Term 1 and Term 3.

The achieving approach dimension measures a student's self-organisation and management of time and resources (Richardson, 2000). Matthew's achieving motive score increased between Term 1 and Term 3 2006 and he continued to score in the top three deciles according to Biggs. His rank in the G&T class with respect to his achieving motive remained stable (rank 3/23). It can be seen in Table 8.8 that his use of strategies in general had also increased. Matthew's increase in strategy use was not confined to the achieving strategy dimension, which is aligned to achieving motive, but as described previously increases were also noted in reported use of surface strategy and deep strategy.

From Term 3 2006 to the end of 2007, the increase in Matthew's deep strategy use was aligned to a slight resurgence in deep motive. Matthew's deep strategy use now placed him in the top three deciles according to Biggs (rank 3/23 in the G&T class). Although Matthew's surface motive score remained constant, he was less inclined to use aligned surface strategy. An increase in achieving strategy use put Matthew in the top three deciles according to Biggs and his rank in the G&T class was 9/23. This increase in achieving strategy use was at odds with a decrease in achieving motive.

According to data available in the literature by Biggs (1987b), Matthew's scores on the LPQ (Table 8.8) did not allow him to be categorised with a specific learning profile at any juncture. Nonetheless, Matthew's composite surface approach score of 45 on the LPQ in Term 3 2006 was in the top three deciles for students of his age (Biggs, 1987b) as was his total achieving approach score of 48. As a consequence, Matthew came very close to the criteria that would have categorised him as a surface/achiever at that time. At the end of 2007, Matthew's composite deep approach score was 43, due predominantly to the deep strategy component, which was in the top three deciles for students of his age.

Table 8.9

Matthew's Results on the cLPQ 2007

	Score on cLPQ dimension					
	Surface Motive SM (20)	Surface Strategy SS (35)	Deep Motive DM (35)	Deep Strategy DS (20)	Achieving Motive AM (30)	Achieving Strategy AS (30)
Term 1 2007	19	21	23	14	23	19
% Scores (x)	95	60	68	70	77	63
Term 3 2007	19	24	22	8	25	21
% Scores (y)	95	69	63	40	83	70
Difference in % scores (y-x)	0	9	-5	-30	6	7

At the beginning of 2007, when GTSP students were assessed using the cLPQ, Matthew was in the Year 9 G&T class. Matthew scored 40 on the surface approach dimension of the cLPQ (see Table 8.9). This was the second highest score on this dimension within the G&T class of the GTSP (rank 2/29). The maximum score possible on the surface approach dimension of the cLPQ was 55. Table 8.9 shows both raw scores on dimensions of the cLPQ and scores as a percentage of the total possible for each dimension for the purpose of comparison, since each dimension had a different total score. Figure 8.3 depicts Matthew's percentage scores for each dimension of the cLPQ in graphical form.

One can see from Figure 8.3, which shows Matthew's cLPQ profile in Term 1 and Term 3 2007, an increase in surface strategy and achieving strategy use, in alignment with a strong achieving motive and continued strong surface motive. Whilst both LPQ and cLPQ data sets show an decrease in deep motive over time, an interesting anomaly is the conflicting results in the use of deep strategy, the LPQ indicating an increase between Term 1 2006 and Term 4 2007 whilst the cLPQ indicated a decline in deep strategy use over 2007 (Term 1 and Term 3). These results highlight the instability in learning approach over time in line with research that suggests that variability in approaches coexists with consistency as students perceptions depend on their learning situations (Biggs, 2003; Prosser & Trigwell, 1999; Ramsden, 2003; Schmeck, 1988).

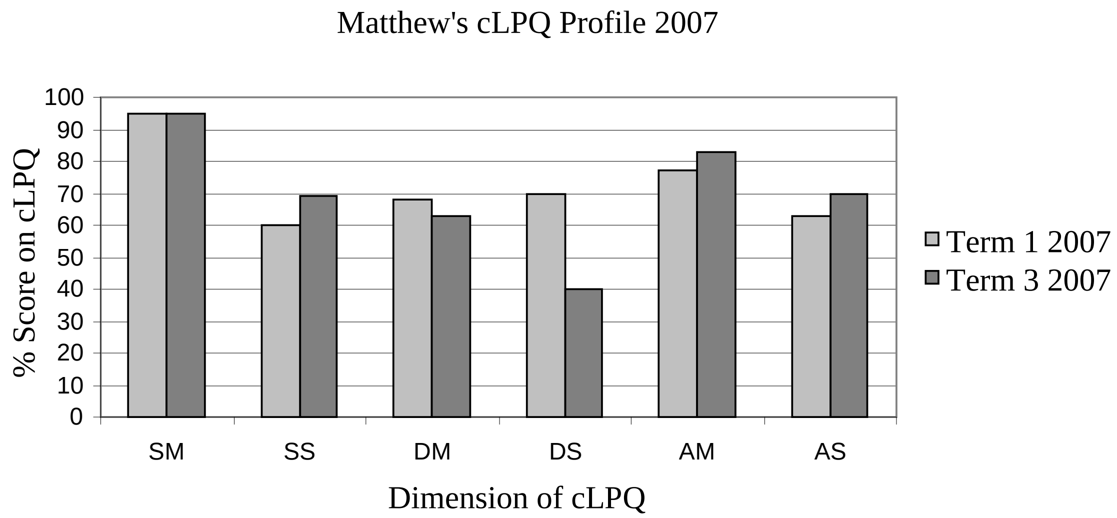

Figure 8.3. Matthew's results on the cLPQ 2007.

It is also to be noted that certain questions on the LPQ classified as indicators of deep strategy, were reclassified as questions relating to deep motive on the R-2F-LPQ (Kember, Biggs, & Leung, 2004), this change in classification was emulated in the development of the cLPQ by the Researcher. A further question in the surface motive dimension of the LPQ was reassigned to the surface strategy dimension in the R-2F-LPQ (and cLPQ). Improvements in the validity of the R-2F-LPQ are likely to be attributed to items being reclassified into a dimension testing the same construct. Although this does not explain changes over time in scores using one particular instrument, it could help explain why there were anomalies in results between the LPQ and cLPQ instruments. Appendix C shows the items from the LPQ that were reclassified on the R-2F-LPQ and subsequently the cLPQ.

Analysis of Matthew's score profile on individual questions of the cLPQ (Term 1 and Term 3 2007) reveals the following information. Matthew was motivated to study by *fear of failure* and the need to get good results as a means of getting a better job. In regards to surface strategy, Matthew indicated a higher preference for memorisation techniques over minimising the scope of his study. Matthew's preference for memorisation was being reinforced over time, as evidenced by the change in his response to Question 27 (Question 27, I find I can get by in most common assessments by memorising key sections rather than trying to understand them). Matthew was not greatly motivated by *commitment to work* or *intrinsic interest*, indeed his predilection to deep motive showed a decline between Term 1 and Term 3 2007, however his response to Question 33 showed a marked increase (Question 33, I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes). This could be the result of an interest in one science area over another; in Term 1 students in Year 9 MHS study geology, in Term 3 they study chemistry. Matthew's scores indicated a marked decline in the use of deep strategy, particularly in *relating ideas* (Question 5, I like constructing theories to fit odd things together). Matthew's recognition of the need to understand new material (Question 28, When I read a textbook, I try to understand what the author means) and to fit this into a prior conceptual framework also declined. CATs and tests at MHS are designed to test students' ability to apply their knowledge. Matthew's failure to achieve in science beyond Level 4 and 5 reflected his limited understanding of concepts. Possibly this is explained by his failure to delve more deeply into concepts when preparing for tests or completing set work. This premise is reinforced by feedback from Matthew's International Competitions and Assessments for Schools (ICAS) statement of results which noted a weakness in interpretation questions.

When preparing for a common assessment task Matthew did not refer to any of the cognitive organisers used in class or set for homework to display information. In an interview situation (29/3/07) when a hypothetical task was presented, Matthew focused on aesthetics. Rather than researching additional information to build a strong argument for a family to start using power from green energy sources, which was the main focus of the task, Matthew described how he would go about representing the base information provided to him in a pleasing way: “I’d make it colourful…like a big border…” (Interview, 29/3/07).

Until a cognitive organiser that Matthew had used in class was discussed with him, he was unable to articulate an appropriate organiser for the task at hand. After discussion, (Interview, 29/3/07) Matthew was able to connect a specific framework with the task that would be of assistance in preparing an argument for persuading his parents to convert to green energy at home. “This one’s [a fishbone] kind of easier to do and organise. You don’t have to make it colourful and everything. You can write the facts down and it’s easier to read.” (Interview, 29/3/07).

Matthew used organisers to display information rather that inter-relate ideas. For example a concept map he was asked to develop about photosynthesis (Artefact, Term 3 2007) was set out as a brainstorm using six subheadings: rate, reagents, products, adaptations, autotrophs and nutrients. Matthew made no attempt to make or articulate links between related concepts. In relation to the SOLO taxonomy, this positioned him at the concrete multi-structural level.

Over the research period, cLPQ analysis reveals that Matthew was becoming more competitive, no longer so concerned about achievement rankings being publicly displayed, or being unpopular with classmates due to high achievement at school. (Question 3, I try to obtain high marks in all my subjects because of the advantage this gives me in competing with others when I leave school, Question 9, I have a strong desire to do best in all of my studies, Question 21, I would rather be highly successful in school even though this might make me unpopular with some of my class mates). As a self-regulatory strategy for learning, he was aware of those students who achieved high test scores and was likely to go to these students for help when he did not understand homework assignments, but he rarely asked parents or siblings for assistance (Interview 9/3/07).

In relation to achieving strategy, although Matthew was unlikely to complete assignments as soon as they were set (Question 18 I always try to do all of my assignments as soon as they are given to me), he indicated that he liked to work throughout the term and particularly before tests (Question 12, I try to work solidly throughout the term and revise regularly when the examinations are close) and learnt from corrections to mistakes (Question 29, When a test is returned, I go over it carefully correcting all errors and trying to under stand why I made the original mistakes). At interview (9/3/07) Matthew stated: “I just study a bit and then closer to the test I study more…this year I study more for tests than last year.”

Matthew’s results on the self-efficacy measure remained relatively stable over the two year research period with scores of 13 (rank 17/23 Term 1, 2006), 13 (rank 16/23 Term 3, 2006), and 15 (rank 18/23 Term 4, 2007). The highest score possible on the self-efficacy measure, indicating a low perception of self-efficacy, was 28; the highest score recorded by a GTSP student on the self-efficacy measure was 20. Matthew’s scores indicated he had a low perception of academic self-efficacy. When Matthew entered MHS he had little science background, this is likely to have affected his perception of his academic self-efficacy, and despite his being selected for the GTSP on the basis of his HAST results. “I didn’t do any science at primary school” (Interview, 9/3/07).

Over time Matthew’s responses on the self-efficacy measure showed he related achievement in science to effort (Question 3, I can do even the hardest work in this science class if I try), however, over time he was less certain that he had the capability to master skills or difficult concepts (Question 2, I’m certain that I can master the skills taught in science this year, Question 7, I’m certain I can figure out how to do the most difficult science work).

Table 8.10 shows Matthew’s results on the revised Individualised Classroom Environment Questionnaire (rICEQ) administered three times over the two year research period (Term 1 2006, Term 3 2006 and Term 4 2007). It also shows Matthew’s perception of the actual classroom environment (Term 3 2006). To assist analysis of changes to Matthew’s preferred classroom environment over time, the difference in scores between Term 1 2006 and Term 4 2007 are noted for each dimension. The maximum score possible on each dimension of the scale is 40.

Over time, Matthew's rICEQ responses showed a marked decrease in his preferences for *Personalisation* and *Independence* (autonomy) and *Differentiation* within science classes (see Table 8.10). He also showed a slight decrease in preference for *Investigation* to answer questions posed by students. When Matthew's perception of the actual classroom environment was surveyed in Term 3 2006 there were marked differences between his perceptions of what was occurring in the science classroom and his preferred classroom environment at that time, the closest match being in the *Participation* dimension. By Term 4 2007, there was a greater difference between his preference and actual classroom environment scores in relation to *Participation*, Matthew one again wishing for greater levels of *Participation* than were offered. However, the differential between preferred and actual classroom environment scores had lessened by 2007 in three of the five dimensions namely: *Personalisation*, *Independence* and *Investigation*.

Table 8.10

Matthew's Results on the rICEQ

	rICEQ scores				
	Personalisation	Participation	Independence	Investigation	Differentiation
Term 1 2006 Preferred (x)	39	30	33	28	36
Term 3 2006 Preferred	35	25	36	30	20
Term 3 2006 Actual	28	23	28	25	27
Term 4 2007 Preferred (y)	29	29	25	26	20
Difference in scores Preferred (y-x)	-10	-1	-8	-2	-16

Note. Maximum score = 40

In school-based assessments Matthew was not demonstrating high achievement. In both 2006 and 2007 he failed to rank in the top 32 students in his cohort (Table 8.11) despite being in the G&T class which had been formed with the premise that it would contain students with the greatest science potential. However, his ranking within his cohort improved markedly from Year 8 to Year 9. MHS based assessments placed him at predominately Level 3 in Year 8, but Year 9 saw improvements such that he was demonstrating Level 4 or 5 (Table 8.12) on the Outcomes and Standards Framework depending on the conceptual context.

Table 8.11

Matthew's School Results 2006 and 2007

	Rank			
MHS cohort	Semester 1	Semester 1 Examination	Semester 2	Semester 2 Examination
Year 8 2006 n = 343	192	Not Applicable	82	Not applicable
Year 9 2007 n = 350	108	78	49	79

Table 8.12

Matthew's School Levels of Achievement 2006 and 2007

	Science Outcome Level				
MHS cohort	Natural & Processed Materials	Life & Living	Investigating Scientifically	Energy & Change	Earth & Beyond
Year 8 2006	3	3	3	3	4
Year 9 2007	5	5	4	5	4

A student operating at Level 3 on the Outcomes and Standards Framework (OSF) is operating at the concrete relational level of the SOLO taxonomy. In Term 3 of

Year 8 Matthew had high surface approach scores on the LPQ measure such that he might be considered to be more inclined towards a surface approach, although he was not strictly classified as a surface learner. Marton (1988) postulated that a surface learner would not be able to operate at a level higher than multistructural, presumably abstract multistructural which relates to Level 5 on the OSF. In Year 8 Matthew was correctly answering questions on MHS assessments based on concrete experiences but not abstract concepts. For example Matthew was able to explain why a swimming pool needed to be refilled more often in summer because of evaporation, but was unable to relate this to particle theory (Year 8 Natural and Processed Materials, Common Assessment Task, 3/4/2006). Also, given information about a hypothetical organism he was able to identify characteristics of living things which were concrete like movement, but not those which were more abstract like respiration (Year 8 Life and Living, Common Assessment Task, 22/5/2006).

By Year 9, Matthew was operating at a higher level, showing evidence on MHS assessments of Level 5 outcomes which relate to the abstract multistructural level of the SOLO taxonomy. It appears that Matthew was better able to answer higher order questions in the Energy and Change and Natural and Processed Materials outcomes, rather than the Earth and Beyond, and Life and Living outcomes. It seems to be that this might be linked to some literacy issues that manifested particularly when Matthew attempted extended answers requiring coherent paragraphs. Examples of such extended answers were describing the passage of water through a plant (Year 9 Life and Living Common Assessment Task, Term 4) and comparing sediments deposited at various positions along a river course (Year 9 Earth and Beyond Common Assessment Task, Term 2). Literacy issues did not preclude Matthew from achieving Level 5 outcomes when answering electricity questions using Ohm's Law calculations (Year 9 Energy and Change Common Assessment Task, 6/3/2007), calculating energy usage (Year 9 Energy and Change Common Assessment Task, Term 1) or when writing balanced equations (Year 9 Natural and Processed Materials Common Assessment Task, Term 3).

With a science score of 489 in the MSE Science Test (Year 9 2007) Matthew was the only student in the G&T class at MHS who did not score in the top 25% of the state. His rank in the MHS Year 9 cohort was 237/337. Matthew achieved just a few marks above the state mean of 484. Although Matthew answered three Level 5 questions correctly, overall he was the only student in the G&T class of the GTSP to be classified as achieving at Level 4 in the MSE Science Test based on the levels of the Outcomes and Standards Framework. Examples from the MSE Science Test 2007 to which Matthew responded and demonstrated Level 4 outcomes include: identifying a change from potential to kinetic energy, understanding the effects of introducing a new species to an ecosystem and identifying production of a new substance as a chemical change. Matthew's fared better on the MSE Mathematics Test ranking 74/337 which was in the top 25% of students in the state (Level 5). It is to be noted that Matthew was placed in the GTSP on the strength of his potential as indicated by his HAST mathematics component score.

Matthew's score on the International Competitions and Assessments for Schools (ICAS) placed him in the 67th percentile of the state (Table 8.13). Feedback from the ICAS indicated that Matthew was in the top 90% in relation to observing/measuring and problem solving, he was above average in predicting concluding, he was below average in investigating, but he was in the bottom 10% in interpreting. As the complexity of questions increases, a weakness in interpretation of background material presented with an item on measures such as the International Competitions and Assessments for Schools will affect the ability to respond correctly. Matthew's results in the National Chemistry Quiz were most disappointing as he was placed in the 11th percentile of the state.

Table 8.13

Matthew's Results on National Science Competitions 2007

National Science Test	Student rank as WA percentile
International Competitions and Assessments for Schools (ICAS)	67
National Chemistry Quiz	11
Australian Mathematics Competition for the Westpac awards	Not provided (Participation Award only)

Summary

Matthew's learning approach scores on the LPQ and cLPQ measures administered over the course of this research when Matthew was in Year 8 and Year 9 showed noticeable variation. In general, though, Matthew had one of the highest surface approach scores within the GTSP.

Matthew's learning approach profile reinforces the findings of Chapter 7, that a student's predilection to address a task in a surface way negatively affects their science achievement. For example it was predicted in Chapter 7 that a student with high surface motive and surface strategy scores generally will fare worse at both state and international level measures of science achievement such as the MSE Science Test. This prediction was borne out in Matthew's MSE and science competition results. At the school level, at MHS, no significant inverse relationship between high surface motive scores and achievement exists, unless the student uses surface strategies. Matthew, with high surface motive and high surface strategy use did not fare as well as others on MHS science achievement measures. Despite there being a significant positive relationship between an achieving approach and achievement on school-based science assessments, any advantage that Matthew may have gained by increases in achieving motive and strategy, were offset by increasing use of surface strategies particularly memorisation.

Despite not faring so well as other GTSP students on CATs, Matthew was still able to demonstrate achievement at Level 5 of the Outcomes and Standards Framework which relates to operating at the abstract multistructural level of the SOLO taxonomy, which is contrary to previous research findings (Marton, 1988) in relation to surface learners.

It appears that in order to maximise effort in line with achieving motive that Matthew increased his use of all strategy types. Students with an achieving approach use whatever strategies they feel they need to succeed (Maehr & McInerney, 2004). Matthew, however, tended to use strategies that related to setting out work that would make it easy to retrieve information rather than focusing on strategies that would assist higher order thinking.

Matthew's results on the rICEQ survey indicated a reduced preference for *Differentiation* in classes. Matthew may have perceived that differentiated activities reduced the framework of support provided to each individual, such that they were clear about exactly what was necessary to do well.

Matthew's limited exposure to science in primary school coupled with his limited achievement in relation to other GTSP students are likely to have lowered his perception of his academic self-efficacy.

Regrettably, Matthew showed a marked deficiency in the interpretation of data. Having observed Matthew in the classroom and having conducted interviews with him, it appears that the reason behind his poor interpretive skills needs further study in particular in relation to any deficit in literacy which was beyond the scope of this study.

Finding 8.2

Matthew was selected into the G&T class of the GTSP, but his levels of achievement did not match those of his peers which likely resulted in his low perception of his self-efficacy. He was, however, able to demonstrate outcomes of a level not expected of a student categorised as a surface learner. Over time Matthew increased his surface approach scores and deep approach scores on the LPQ, an indication of study orchestration. Matthew's preferred learning environment did not align with that of his teacher particularly with respect to *differentiation*.

Case Three Wade

Of the Year 8 students selected for the GTSP in 2006, Wade (previously identified as Student 3 in Chapter 5) had the highest mathematics component score on the HAST at 68 (rank 1/23) and also a high overall score on the HAST of 189 (rank 7/23).

Table 8.14 shows Wade's scores on the LPQ at three points during the research period: at the beginning of Year 8 2006, Term 3 2006 and the end of Year 9 2007. The distribution of Wade's scores on the three dimensions of the LPQ did not allow his categorisation into any specific learning approach profile according to Biggs (1987b). However, Wade's total surface approach score of 45 on the LPQ at the end of 2006 was in the top three deciles for students of his age (Biggs, 1987b). As a consequence, Wade came very close to the criteria that would have categorised him as a surface learner at that time.

Table 8.14

Wade's Results on the LPQ

	Score on LPQ dimension					
	Surface Motive	Surface Strategy	Deep Motive	Deep Strategy	Achieving Motive	Achieving Strategy
Term 1 2006 (x)	22	15	21	17	19	23
LPQ classification [a]	0	-	0	0	0	+
Term 3 2006	25	20	19	19	26	16
LPQ classification	+	0	0	0	+	0
Term 4 2007 (y)	22	20	19	11	25	15
LPQ classification	0	0	0	-	+	0
Difference in LPQ scores (y-x)	0	5	-2	-6	6	-8

Note. Maximum score = 30

[a] - negative predilection, + positive predilection, 0 no predilection

Results of the LPQ surveys for Wade show an increase in his surface strategy score by five over time (see Table 8.14). As Wade increased his use of surface strategy, his use of both deep and achieving strategies declined. Note the decline in deep strategy score by six and decline in achieving strategy score by eight (Table 8.14), both substantial declines considering the total score on each dimension of the LPQ is 30. Over time Wade demonstrated a stronger preference for achieving motive as indicated by his score on the achieving motive dimension increasing by six.

The GTSP students were assessed on the cLPQ at the beginning of 2007. In 2007 Wade was in Year 9 and scored 40 on the surface approach dimension of the cLPQ (Table 8.15). This was the second highest score within the G&T class of the GTSP (rank 2/29) along with Matthew. The highest score possible on this dimension is 55. Table 8.15 shows Wade's raw scores on each dimension of the cLPQ and these scores as a percentage of the total score possible for the purpose of comparison, since each dimension had a different total score. Figure 8.4 depicts Wade's percentage scores for each dimension of the cLPQ in graphical format.

Table 8.15

Wade's Results on the cLPQ 2007

	Score on cLPQ dimension					
	Surface Motive SM (20)	Surface Strategy SS (35)	Deep Motive DM (35)	Deep Strategy DS (20)	Achieving Motive AM (30)	Achieving Strategy AS (30)
Term 1 2007	17	23	19	11	24	22
% Scores (x)	85	66	54	55	80	73
Term 3 2007	14	26	14	9	23	16
% Scores (y)	70	74	40	45	77	53
Difference in % scores (y-x)	-15	8	-14	-10	-3	-20

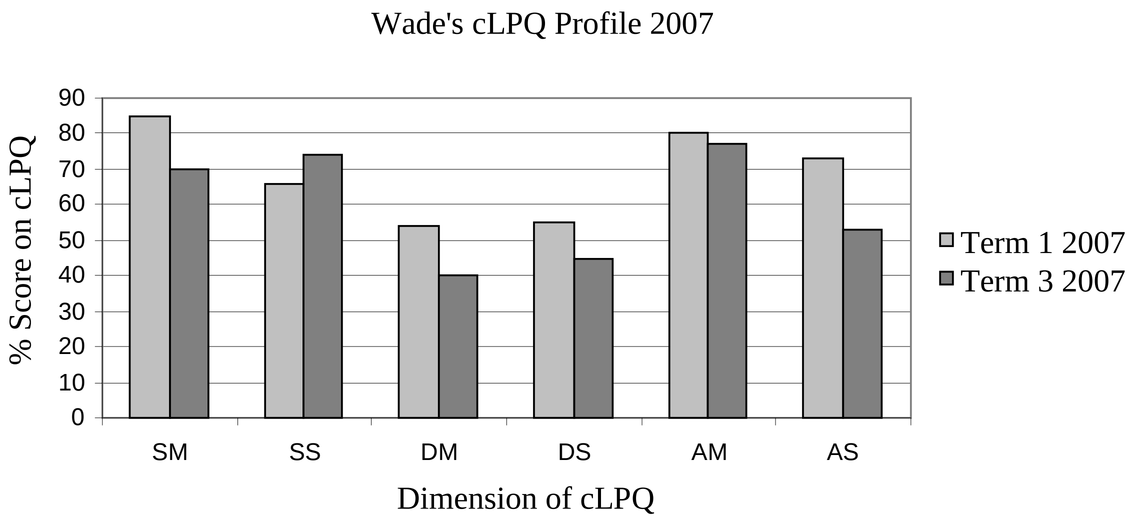

Figure 8.4. Wade’s results on the cLPQ 2007.

Table 8.15 and Figure 8.4 show the trends in Wade’s cLPQ scores between Term 1 2007 and Term 3 2007. Wade’s scores on the cLPQ indicate a decline in surface and deep motive scores over time. Changes to Wade’s raw scores on the cLPQ are far more apparent than trends noted by changes his LPQ scores (Table 8.14). The decline in achieving motive scores (cLPQ) was marginal. However, this decline was contrary to results from the LPQ which indicated an increase in achieving motive over the two year period. Since the achieving motive dimension of the LPQ and cLPQ uses the same test items, suffice to say that Wade’s achieving motive scores fluctuated over the research period, with Wade’s results indicating a general increase between Year 8 and Year 9. Like the LPQ, the cLPQ survey results for Wade show a decline in deep and achieving strategy use and an increase in surface strategy use.

More in-depth analysis of trends within Wade’s responses on the cLPQ reveals the following information. Within the surface motive dimension Wade seemed less motivated by *fear of failure* as time passed (Question 7, I am discouraged by a poor mark on a test and worry about how I will do on the next test and Question 19, Even when I have studied hard for a test, I worry that I may not be able to do well in it), although he remained motivated by *aim for qualification* for employment (Question 1, Whether I like it or not, I can see that doing well in school is a good way to get a well paid job and Question 13, I intend to study to year 12 or beyond because I feel that I will then be able to get a better job). Wade began to narrow his scope of study over time to material likely to be tested (Question 22, As long as I feel I am doing enough to pass tests, I devote as little time to studying as I can. There are many more interesting things to do); his use of *memorisation* remained similar (Question 27, I find I can get by in most common assessments by memorising key sections rather than trying to understand them).

In relation to deep motive, Wade was less likely to spend time thinking over school work as time progressed. Wade's response to Question 30 dropped from frequently to never or only rarely (Question 30, I find that I am continually going over my school work in my mind at times like when I am on the bus, walking, or lying in bed, and so on). This response in some ways seems linked to *minimising scope of study*. Wade did not attempt to read for *understanding* as a deep strategy and was not concerned with trying to build a conceptual framework in order to clarify concepts (Question 11, I try to relate new material, as I am reading it, to what I already know on that topic).

Although Wade was keen to achieve (Question 3, I try to obtain high marks in all my subjects because of the advantage this gives me in competing with others when I leave school), the strategies he used were not aligned to this motive. He was unlikely to read through his notes or make summaries to assist learning on a regular basis (Question 6, I regularly take notes from suggested readings and put them with my class notes on a topic and Question 24, Soon after a class or lab, I re-read my notes to make sure I can read them and understand them).

During an interview which related to preparation for a CAT (Interview 8/03/07), Wade stated that he started preparing about a week prior to the CAT. He read through the textbook chapters and got friends to test him the day before the test. "I started reading the chapter. I think it was on energy or electrical… I just went over the key aspects like Ohms, voltage, amps and circuits" (Interview 8/03/07). When asked if he made summary notes Wade replied: "Sometimes…I just bullet the key points. I just try to memorise them. I just look them over and get people to test me" (Interview 8/03/07). Wade was more likely to target resources other than his textbook when he was unsure about a key concept. "I usually go to like [sic] the public library" (Interview 8/03/07).

Wade also indicated that he would use multiple resources for a more in depth task like the hypothetical green energy assessment. “I would go on the internet and find out what would happen, the effects if we go on using coal and that to generate electricity . . . and what would happen if we generate green energy” (Interview 27/3/07). Wade’s ideas concerning how to present his arguments for the green energy task centred on aesthetics rather than detail. “I would sort of make it like a pamphlet. . . . not that much writing. . . . You know it looks like really professionally done” (Interview 27/3/07).

So with some of his highest scores in the surface dimension, which is what Biggs suggests is a learning pathology (Biggs & Moore, 1993), one would not expect Wade to be succeeding in science. Nonetheless, Tables 8.16-8.18 show clearly that Wade’s approach to learning is serving him well at this stage. Wade’s school-based results were excellent and his rankings confirmed his placement in the top science class.

Table 8.16

Wade’s School Results 2006 and 2007

	Rank			
MHS cohort	Semester 1	Semester 1 Examination	Semester 2	Semester 2 Examination
Year 8 2006 n = 343	31	Not applicable	17	Not applicable
Year 9 2007 n = 350	9	5	2	2

In Year 8 Wade was showing evidence in MHS assessments that placed him at Levels 4 and 5 on the Outcomes and Standards Framework (OSF) (see Table 8.17). In relation to the SOLO taxonomy he was operating at the abstract unistructural and abstract multistructural levels. By the time Wade was in Year 9 he was showing evidence of Level 6 outcomes in other words explanations at the abstract relational level. Examples of work from artefacts collected include: Level 4, explains how to set up equipment to allow two liquids with different boiling points to reach their boiling point at the same time (Year 8 Natural and Processed Materials Common Assessment Task); Level 5, describes the deposition of clastic sediments according to grain size and the energy of the environment of deposition (Year 9 Semester One Examination); relates the use of metals to several independent properties (Year 9 Natural and Processed Materials Test) ; Level 6, using data of current and voltage and applying Ohm's law prove that a globe in a circuit is non-Ohmic (Year 9 Energy and Change Common Assessment Task, 6/3/2007); interprets graphical representations of photosynthesis and respiration (Year 9 Life and Living Common Assessment Task).

Table 8.17

Wade's School Levels of Achievement 2006 and 2007

	Science Outcome Level				
MHS cohort	Natural & Processed Materials	Life & Living	Investigating Scientifically	Energy & Change	Earth & Beyond
Year 8 2006	4	4	4	4	5
Year 9 2007	6	6	5	5	5

In the MSE Science Test Wade was one of the top students in the G&T class (rank 2/ 29) and in the Year 9 cohort (rank 5/ 350) with a score of 632. He was levelled 5 on the OSF having answered 17 out of 25 Level 5 questions correctly. Examples of items from the MSE Science Test 2007 to which Wade demonstrated Level 5 outcomes include: recognises energy transformations in a simple machine, recalls the agents causing erosion, is aware that animal populations may adapt to pathogens over time, uses particle theory to explain why a balloon expands in the sun, recognises and explains why a chemical equation is unbalanced and explains energy transfer in a greenhouse in scientific terms. In the MSE Mathematics Test Wade had an almost perfect score; he scored 747 and only got one answer (Level 4/5) incorrect. The MSE does not assess achievement beyond Level 5.

It was not only on school and state level assessments that Wade was excelling, in national science competitions Wade's results were very competitive (Table 8.18). In the International Competitions and Assessments for Schools (ICAS) 2007 he scored in the 99th percentile of the state and received a certificate of high distinction. Analysis received by the school in relation to the ICAS indicated Wade's particular areas of strength were in predicting/concluding, investigating and problem solving; furthermore he was in the 90th percentile for observing measuring and interpreting. In the National Chemistry Quiz 2007 he scored in the 82nd percentile and received a certificate of distinction for his efforts. Wade's results in general support his being categorised as academically gifted in science. In mathematics Wade's results in the Australian Mathematics Competition for the Westpac awards also support his classification as gifted in mathematics.

Table 8.18

Wade's Results on National Science Competitions

National Science Test	Student rank as WA percentile
International Competitions and Assessments for Schools (ICAS)	99
National Chemistry Quiz	82
Australian Mathematics Competition for the Westpac awards	99

Wade had a relatively low score on the self-efficacy measure indicating confidence in his ability to succeed in science (Question 2, I'm certain that I can master the skills taught in science this year). The lowest score on the self-efficacy measure, indicating the highest self-efficacy of learning was 7. Wade's score remained relatively stable over time with scores of 11 (rank 8/23 Term 1, 2006), 9, (rank 6/23 Term 3, 2006) and 10 (rank 8/23 Term 4, 2007).

On the rICEQ the maximum score on any dimension is 40 and the minimum is 10. Wade's perceptions of the ideal science classroom environment changed markedly over time. Wade's responses indicate that by the end of Year 9 his preference for differentiated learning had declined (Table 8.19). The *Differentiation* dimension of the rICEQ measures the degree to which the student wishes the classroom learning to be tailored to their individual needs in terms of pace, content, level of difficulty and teaching methods. Wade's responses at Term 4 Year 9 indicate a wish for all students to be taught the same material, regardless of ability range, using the same resources (Question 10**,** All students would use the same resources for their class work and assignments). These responses are consistent with Wade's learning approach profile at that time which indicated a preference for minimising the scope of study.

Table 8.19

Wade's Results on the rICEQ

	rICEQ scores				
	Personalisation	Participation	Independence	Investigation	Differentiation
Term 1 2006 Preferred (x)	28	29	31	33	28
Term 3 2006 Preferred	28	30	35	32	28
Term 3 2006 Actual	23	25	24	23	18
Term 4 2007 Preferred (y)	22	24	28	29	15
Difference in scores Preferred (y-x)	-6	-5	-3	-4	-13

Note. Maximum score = 40

In the *Personalisation* dimension it appeared that Wade did not need to feel connected with the teacher, although he valued assistance when having difficulty. At the start of Year 8 he had expressed preference for the teacher finding out about each child's area of interest (Question 41, The teacher would try to find out what each student wanted to learn about) but by the end of Year 9 this was no longer the case. In the *Participation* dimension a shift towards a preference for a transmissive mode of teaching was noted (Question 32, Students would sit and listen to the teacher and Question 7, The teacher would talk rather than listen).

In the *Independence* dimension the pattern of Wade's responses indicated that he was increasingly aware of a need to be directed in his studies (Question13, Students would be told exactly how to do their work), however he valued taking part in the negotiation of assessment rubrics (Question 43, Students would negotiate some parts of the assessment marking keys). He was more accepting of the teacher's role in classroom management, deciding seating arrangements and group membership (Question 33, The teacher would decide which students should work together and Question 48, The teacher would decide how much movement and talk there should be in class), but valued autonomy when set group assignments in terms of roles, work allocation and time management (Question 18, Students would decide on the distribution of work during group activities, Question 28, Students would manage their own time on long term assignments and Question 38, Students would decide on the best way to make notes during class).

In the *Investigation* dimension Wade's preference for investigating a problem of interest to him declined from Year 8 to Year 9. In Year 9 Wade's responses indicated that he did not like to find answers to problems from textbooks (Question 4, Students would find out the answers to questions from textbooks rather than from practical investigations). Wade preferred practical investigations and other means of problem solving (Question14, Students would carry out practical investigations to test ideas and Question 49, Students would solve problems by obtaining information from many sources). However, Wade preferred to investigate a problem outlined by the teacher (Question 44, Practical investigations would be used to answer questions posed by the teacher) rather than one of his own. Note that while the actual classroom environment did not meet his preference in Year 8, by Year 9 the emphasis in class on *Investigation* was greater than Wade's personal preference.

Summary

The literature indicates the negative effect of a surface approach on achievement. Significant negative correlation values were found for surface strategy against all the measures of achievement used in the GTSP, as discussed in Chapter 7. It is to be noted that the results of the LPQ surveys for Wade show an increase in his surface strategy score by five over time (Table 8.14).

However, this research suggests significant positive correlations between achieving motive and achieving strategy with MHS measures of science achievement (see Chapter 7). So the fact that Wade's achieving motive scores on the LPQ increased over the research period should be beneficial. Any positive effect of this may however, be negated by his decline in use of achieving strategy over the same time frame.

Adaptation by students of their learning approach to their perception of what is required is called 'study orchestration' ". . . students react by tuning their approach to learning to suit the environment to which they were exposed" (Biggs, 2003, p. 25). In Wade's case a more open assessment task relating to green energy caused him to select a more in depth approach to research, utilising multiple resources and application of knowledge. The CAT evoked only memorisation techniques using a single resource.

It appears the GTSP students' evaluation of the situation makes earning high grades in high stakes MHS tests more important than understanding the material. Thus, they are pushed towards inappropriate surface approaches to appease teachers and ensure their place in the program (Biggs, 2003; Ramsden, 2003). When the assessment determines what and how students learn more than the curriculum does, this is called backwash (Biggs, 2003, p. 140).

A person with an achieving motive will do whatever it takes to progress. If progress is measured by results on school-based assessment and a student does better by narrowing their focus this is what they will do. An increase in surface strategy to increase memorisation of material presented by the teacher may be what the student sees as the way to achieve. High achievement for Wade was likely the reason for his feelings of positive self-efficacy. Narrowing of focus in an attempt to achieve high marks appears to result in a marked decline in his preference to be exposed to a differentiated curriculum. This is reflected in a change in Wade's preferred classroom environment.

Finding 8.3

Despite exhibiting a surface approach, Wade was a very high achiever with a positive perception of his self-efficacy. Over time Wade's deep approach scores declined, therefore Wade's achievement was likely to be attributed to his use of surface strategies such as memorisation of facts rather than the use of cognitive organisers such as concept maps. Wade's preference for *differentiation* of the curriculum showed a marked decline over time.

Case Four Patricia

Patricia (previously identified as Student 11 in Chapter 5) had the highest HAST score of all students entering the G&T class of the GTSP in Year 8 with a score of 208. Patricia's mathematics component score was very high at 65 since the highest mathematics component score on the HAST of students in the G&T class was 68. At the beginning of 2007 when Patricia was in Year 9 she scored 25 on the surface approach dimension of the cLPQ. This was the second lowest score within the G&T class, indicating that her learning strategy went beyond mere acquisition of facts.

At the end of Year 8 Patricia scored a surface approach score of 25 on the LPQ which was in the bottom three deciles for students of her age. Patricia's LPQ classification at three points during the research period, made with reference to published deciles (Biggs, 1987b) is shown in Table 8.20. Yet the distribution of Patricia's scores on the three dimensions of the LPQ did not allow categorisation into any specific learning approach profile according to Biggs (1987b). However, profiles similar to Patricia's namely 00 00 -0 or +0 00 -0 correspond to those of low achieving learners in the related literature (Biggs, 1987b). Although over time Patricia was less inclined towards a surface or achieving motive, she apparently had no strong prevalent motive for learning at any stage as indicated by the LPQ data. Similarly in relation to strategy, it was difficult to see any type of strategy preference for Patricia, although there was a slight increase towards her use of surface strategy use by the end of Year 9 (Table 8.20).

Table 8.20

Patricia's Results on the LPQ

	Score on LPQ Dimension					
	Surface Motive	Surface Strategy	Deep Motive	Deep Strategy	Achieving Motive	Achieving Strategy
Term 1 2006 (x)	20	12	19	18	20	17
LPQ classification [a]	0	-	0	0	0	0
Term 3 2006	16	9	20	15	18	17
LPQ Classification	-	-	0	0	0	0
Term 4 2007 (y)	18	15	19	19	17	18
LPQ classification	-	0	0	0	-	0
Difference in LPQ scores (y-x)	-2	3	0	1	-3	1

Note. Maximum score = 30

[a] - negative predilection, + positive predilection, 0 no predilection

Table 8.21 and Figure 8.5 show the results of Patricia's cLPQ surveys in Term 1 2007 and Term 3 2007. Patricia's scores on the cLPQ indicate increases in all three motive dimensions surface, deep and achieving; however, the most noticeable increase was in surface motive. Patricia was also increasing her use of deep and achieving strategy over time. Comparisons of the results of LPQ and cLPQ survey for Patricia reflect the variability in learning approach over time. Patterns of change in LPQ scores are not reflected in the cLPQ scores.

Table 8.21

Patricia's Results on the cLPQ

	Score on cLPQ dimension					
	Surface Motive SM (20)	Surface Strategy SS (35)	Deep Motive DM (35)	Deep Strategy DS (20)	Achieving Motive AM (30)	Achieving Strategy AS (30)
Term 1 2007	15	10	20	14	18	18
% Scores (x)	75	29	57	70	60	60
Term 3 2007	18	10	23	16	19	22
% Scores (y)	90	29	66	80	63	73
Difference in % scores (y-x)	15	0	9	10	3	13

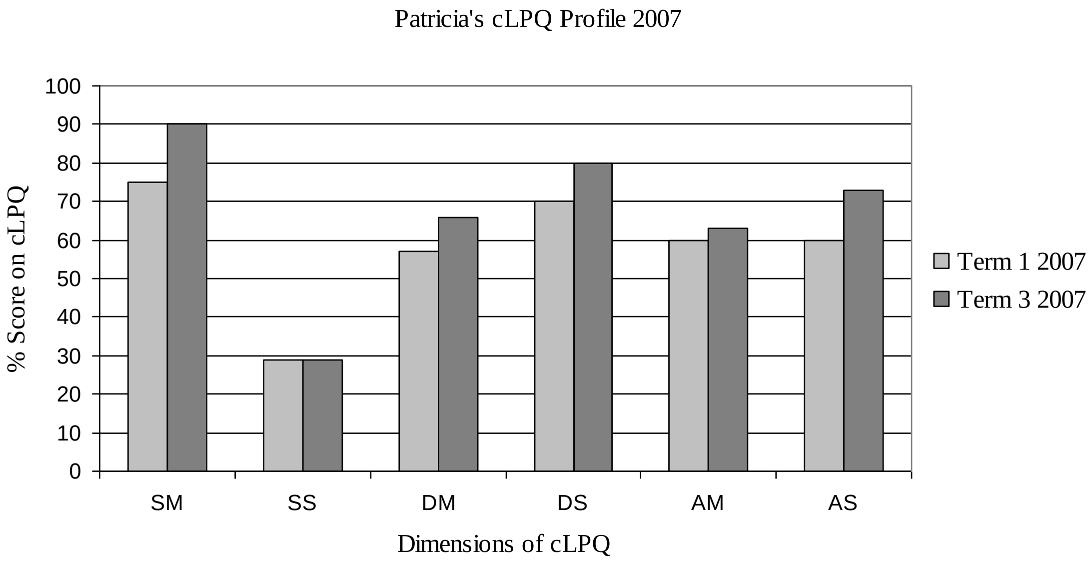

Figure 8.5. Patricia's results on the cLPQ 2007.

A deeper analysis of Patricia's scores on the cLPQ reveals the following. In the surface motive dimension she was particularly motivated by *aim for qualification* although as time progressed her surface motivation increased to avoid *fear of failure*. Her responses in the surface strategy dimension remained constant between the two periods of testing. Although inclined to remember answers to likely questions, Patricia had an aversion to *memorisation* (Q27 Question 27, I find I can get by in most common assessments by memorising key sections rather than trying to understand them).

In preparing for a CAT she sought the help of others in determining what questions might be asked. “I talked with friends, just seeing what everyone else thought the test might be about” (Interview, 6/3/07).

Within the deep motive dimension, Patricia scored higher on questions relating to *intrinsic interest* (Question 20, I work hard at my studies because I find the material interesting), than *commitment to work* (Question 17, I like to do enough work on a topic so that I can form my own conclusions, before I am satisfied). Patricia was less likely to use deep strategy like *relating ideas* (Question 5, I like constructing theories to fit odd things together), than to reading for *understanding* (Question 28, When I read a textbook, I try to understand what the author means). However, at interview Patricia indicated how mind maps assisted her learning for CATs. “I think mind maps are really helpful, because they help you organise your ideas and we’ve done some previously in class” (Interview, 6/3/07). A greater focus on *relating ideas* may have assisted Patricia to score higher marks on questions in CATs which required justification of statements made.

With respect to achieving motive, Patricia did not like rankings being posted or learning being regarded as a type of competition (Question 15, I like the results of tests to be put up publicly so I can see by how much I beat some others in the class), although she was motivated to do the best that she could at school despite what her peers might think (Question 21, I would rather be highly successful in school even though this might make me unpopular with some of my class mates). Over time Patricia showed an increase in the use of achieving strategy (cLPQ), in particular in relation to making summary notes (Question 6, I regularly take notes from suggested readings and put them with my class notes on a topic) and completing assignments in a timely fashion (Question 18, I always try to do all of my assignments as soon as they are given to me). At interview when asked about preparations for a CAT Patricia responded:

> I looked at the science book and I summarised each of the chapters…I used phrases and some key words and definitions . . . I knew there was a long weekend coming up so I studied over the long weekend. (Interview, 6/3/07)

A spider diagram that Patricia completed on electricity was a composite of summary notes on key concepts like circuits, conductors and insulators as discreet topics rather than showing the interrelationships between the concepts (Task: Spider diagram, 9/2/07).

In Patricia's portfolio there was evidence that Patricia had annotated her work samples with correct answers after the teacher had gone over the work in class (Task, Energy and Change Common Assessment Task, 6/3/07).

Patricia's examination and semester marks in both Year 8 and Year 9 placed her in the top 30 of the cohort and confirmed her placement in the G&T class of the GTSP (Table 8.22). In relation to the Outcomes and Standards Framework (OSF), Patricia consistently demonstrated achievement of outcomes at Level 5 or 6 on school-based assessments in Year 9 (Table 8.23). In relation to the SOLO taxonomy she was operating at the abstract multistructural and abstract relational levels. Few students in the Year 9 cohort were able to achieve demonstrations of Level 6 outcomes on the OSF. Examples of school-based assessments in which Patricia displayed achievement of Level 6 outcomes were: an explanation of the steps required to transform a sample of metamorphic schist into a granite batholith weathering on the surface (Year 9 Earth and Beyond Common Assessment Task), use of data from a circuit diagram to prove that a globe is non-Ohmic (Year 9 Energy and Change Common Assessment Task) and an interpretation of graphs showing the rates of photosynthesis and respiration in a plant throughout the day and compensation point (Year 9 Life and Living Common Assessment Task).

Table 8.22

Patricia's School Results 2006 and 2007

	Rank			
MHS cohort	Semester 1	Semester 1 Examination	Semester 2	Semester 2 Examination
Year 8 2006 n = 343	21	Not applicable	21	Not applicable
Year 9 2007 n = 350	2	6	9	25

Table 8.23

Patricia's School Levels of Achievement 2006 and 2007

	Science Outcome Level				
MHS cohort	Natural & Processed Materials	Life & Living	Investigating Scientifically	Energy & Change	Earth & Beyond
Year 8 2006	4	4	4	4	5
Year 9 2007	6	5	5	6	6

With a science score of 632 on the MSE Science Test Patricia was one of the top students in the Year 9 MHS cohort and was ranked fifth, with five others, from the G&T class. On the MSE Science Test she was awarded a Level 5 on the OSF having achieved 16 of a possible 25 Level 5 questions correct. Had the MSE Science Test included questions testing Level 6 outcomes it is likely that Patricia would have been able to demonstrate outcomes at Level 6. Examples of items from the MSE Science Test 2007 to which Patricia demonstrated Level 5 outcomes include: uses particle theory to explain why a balloon expands in the sun, recognises and explains why a chemical equation is unbalanced, recognises that insulating materials can affect the flow of energy and makes connections between living things and their environment. In the MSE Mathematics Test, Patricia achieved a perfect score of 794. Only seven students in the

MHS Year 9 cohort received a perfect score. Neither the MSE Science Test nor the MSE Mathematics Test included questions that assessed beyond Level 5.

In national testing Patricia achieved commendable results in the International Competitions and Assessments for Schools (ICAS) and the National Chemistry Quiz (Table 8.24). In the ICAS 2007 she was placed in the top two per cent of students in WA and received a certificate of distinction. Patricia received strong results in all elements: observing, interpreting, predicting and investigating, but her particular strength was in problem solving. Patricia also received a certificate of credit for her participation in the National Chemistry Quiz. Patricia was also one of the top students in the Australian Mathematics Competition for the Westpac awards being in the 100th percentile in the state for which she was presented with the highest award, a prize.

Table 8.24

Patricia's Results on National Science Competitions 2007

National Science Test	Student rank as WA percentile
International Competitions and Assessments for Schools (ICAS)	98
National Chemistry Quiz	72
Australian Mathematics Competition for the Westpac awards	100

Patricia had a relatively low score on the self-efficacy measure indicating confidence in her ability to master science skills. The highest score on this measure was 28, a high score indicating low academic self-efficacy. Patricia was becoming more confident in her academic self-efficacy with time, her score on the self-efficacy measure decreased from 13 (rank 17/23) at the start of Year 8 to 8 (rank 4/23) at the end of Year 9. Positive feedback from the results of school, state and national testing contributed to this change. In particular by the end of Year 9 Patricia was convinced that she could accomplish the most difficult science (Question 7, I'm certain I can figure out how to do the most difficult science work).

Patricia's perceptions of the classroom environment were assessed using the rICEQ measure (Table 8.25). On the *Personalisation* dimension, which measures the interrelationship between teacher and student, there was little change in Patricia's score between the start of Year 8 and the end of Year 9. It was noted that Patricia's response pattern to Question 46 showed the greatest change (Question 46, The teacher would use assessments to find out where each student needed help). In Year 8 Patricia had scored 4 (almost always) on this item whereas in Year 9 she scored this item 2 (sometimes).

Table 8.25

Patricia's Results on the rICEQ

	rICEQ scores				
	Personalisation	Participation	Independence	Investigation	Differentiation
Term 1 2006 Preferred (x)	30	35	34	39	33
Term 3 2006 Preferred	26	33	28	31	27
Term 3 2006 Actual	27	33	29	35	31
Term 4 2007 Preferred (y)	31	34	27	29	24
Difference in scores Preferred (y-x)	1	-1	-7	-10	-9

Note. Maximum score = 40

Similarly in the *Participation* dimension there was little change in Patricia's preferred score between the start of Year 8 and the end of Year 9. This dimension probes the extent to which the student wishes to be actively engaged in class. During a lesson where students were investigating the differences between series and parallel circuits, Patricia was observed annotating her circuit diagram as the teacher spoke prior to engaging in the practical component of the lesson (Participant Observation, Lesson 5, 8/2/07). This was the dimension that there was the greatest degree of alignment between the student's preferred classroom environment and the actual classroom environment.

Patricia started Year 8 with a relatively high score in the *Independence* dimension, indicating her wish for a fair degree of student autonomy in science classes. This preference was upheld in those questions that related to decisions about task management (Question 28, Students would manage their own time on long term assignments and Question 38, Students would decide on the best way to make notes during class). Over time her scores on such items reflected her understanding of the need for teacher input on some occasions (Question 13, students would be told exactly how to do their work), with the result of a seven point drop in total score on the *Independence* dimension by the end of Year 9. Although her responses to questions related to classroom management issues (Question 3, The teacher would decide where students sat) indicated her preference for decisions from the teacher, as she matured, she increasingly wanted to be more in control of the classroom dynamics (Question 48, The teacher would decide how much movement and talk there should be in class).

Students entering Year 8 are keen to begin investigations in science. Some students enter high school with little experience of investigative work. As such Patricia's scores on the *Investigation* dimension at the start of Year 8 were typical; she wished to answer science problems through her own practical investigations. Often students do not associate the enjoyment of practical based classes with the rigour of justifying conclusions drawn from their results. The use of background science knowledge to explain patterns and trends in data is a determinant in levelling students in the investigation strand of the Outcomes and Standards Framework.

Patricia was less inclined to see the importance of justifying conclusion based on data (Question 24, Students would be asked to think about the evidence behind statements). However, during an interview about a hypothetical task she conceded that she would need to provide evidence to substantiate reasons for changing to green power.

> It would be good to show some evidence, not just what I've written, but something like this pamphlet here, where you can show them (parents) that it's not just me . . . use evidence to support your reasons. (Interview 27/3/07)

Patricia's preference for *Investigation* waned over the years as indicated by the 10 point decline in scores in this dimension. The need for including *Investigation* from the teacher's perspective was greater than Patricia's preference. Working scientifically, which includes investigations, is the only strand of science for which an achievement target is set for Year 9 students as measured by a component of the MSE Science Test.

Patricia's preference for *Differentiation* of the curriculum declined over time, until she perceived that the degree of *Differentiation* occurring in class was greater than her preferred learning environment. The greatest change came in Patricia's responses to questions related to the difficulty level of work and amount of work attempted in class (Question 25, Students would work to different levels on assignments according to their ability and Question 50, All students would be expected to do the same amount of work in the lesson). In Year 8 Patricia responded that students should sometimes be expected to work on different levels of assessments according to their ability and sometimes be expected to do the same amount of work. In Year 9 she responded that students should almost always be working on different levels of task according to ability, but almost always be expected to do the same amount of work, which appears contradictory. Patricia's Year 9 responses to Question 20 (Students would do different work according to their ability) and Question25 (see above) which both probe the same idea were also inconsistent. In response to Question 20 which asked about doing different work, without mentioning levels which has a particular connotation in WA schools, Patricia responded sometimes. It appears that Patricia is happy for tasks to be differentiated for assessment purposes, but in class wishes to do the same set work as others.

Outside of class Patricia was prepared to spend extra time on tasks that allowed students to present their work in any way they saw fit. During a differentiated activity in Term 1, the class was set a creative piece to explain the concept of electricity. Students could present a puppet show, compose some music, make a power point presentation or use any other means to demonstrate their understanding. Patricia's portfolio contained a comic strip she had created on the topic with 12 key characters (Task: The Circuit 15/2/07). The cartoon strip explained: how electrons in a circuit get their energy; how energy is lost; the concept of resistance in a circuit and the role of a switch in the circuit. The detail evident in this cartoon indicated that Patricia had spent a good deal of time thinking about how the characters could behave like the components of a circuit in the real world to help explain the concept of electricity. Her cartoon demonstrated understanding at the abstract relational level of the SOLO taxonomy.

Summary

Patricia's lack of motive and aligned strategy, in accordance with Bigg's classification, suggests this is the mark of a low achiever. Yet Patricia was displaying results far in advance of her cohort. If a student has talent in a in a particular field then they will display results in the top 10% of the cohort (Gagné, 2006). Patricia's achievement on tests designed for the top science and mathematics students in the country, namely the International Competitions and Assessments for Schools (ICAS) and the Australian Mathematics Competition for the Westpac awards indicate her superior achievement. Her lack of clear preference for a particular approach to learning appeared not to hinder her achievement; she simply adopted the most efficient strategies for successful completion of a task.

Despite a lack of predisposition to any particular learning approach, there was evidence that Patricia, when motivated, was able to use self-regulatory strategies such as note annotation and concept mapping to deepen her understanding. She also displayed evidence to commit considerable effort to the personalisation of learning tasks such as the electricity cartoon strip.

In class Patricia wished to be guided by the teacher's perspective of the important parts of the course. She did not want to engage in work beyond the curriculum or investigate beyond what would be tested. For assignments she was happy to utilise her creative flair in the demonstration of her understanding, but for CATs it appeared that she could rely on her innate understanding and minimal preparation to achieve high marks.

Finding 8.4

Patricia's innate ability allowed her to achieve outstanding results despite the fact that she did not exhibit any a particular learning approach. Many of the assessments to which Patricia was exposed did not adequately measure the extent of her capabilities as they did not provide sufficient cognitive challenge. Although Patricia's surface motive scores increased over time, she purposely selected strategies to match the task at hand and this allowed her to achieve success. Patricia was confident in her ability in science as indicated by her positive self-efficacy. Patricia perceived that the GTSP involved too much *differentiation*.

Chapter 8 has reported four case studies of students studying within the GTSP over two years when they were in Year 8 and Year 9. Table 8.26 summarises the findings of the case studies from this chapter.

Table 8.26

Summary of Findings from the Four Case Studies

	Findings
8.1	Although Graham was not initially selected for the G&T class in Year 8, he demonstrated excellent levels of achievement throughout Year 8 and Year 9. Graham was a deep/achiever with a high perception of his self-efficacy. His confidence allowed him to assist others through peer teaching. Graham applied his deep motive for learning by utilising deep strategies that facilitated the expansion of his conceptual understanding. However, he was loath to commit his understanding of conceptual relationships to paper by way of strategies such as concept mapping. As a deep learner his perceptions of an ideal classroom environment matched those of his teacher.
8.2	Matthew was selected into the G&T class of the GTSP, but his levels of achievement did not match those of his peers which likely resulted in his low perception of his self-efficacy. He was, however, able to demonstrate outcomes of a level not expected of a student categorised as a surface learner. Over time Matthew increased his surface approach scores and deep approach scores on the LPQ, an indication of study orchestration. Matthew's preferred learning environment did not align with that of his teacher particularly with respect to *differentiation*.
8.3	Despite exhibiting a surface approach, Wade was a very high achiever with a positive perception of his self-efficacy. Over time Wade's deep approach scores declined, therefore Wade's achievement was likely to be attributed to his use of surface strategies such as memorisation of facts rather than the use of cognitive organisers such as concept maps. Wade's preference for *differentiation* of the curriculum showed a marked decline over time.
8.4	Patricia's innate ability allowed her to achieve outstanding results despite the fact that she did not exhibit any a particular learning approach. Many of the assessments to which Patricia was exposed did not adequately measure the extent of her capabilities as they did not provide sufficient cognitive challenge. Although Patricia's surface motive scores increased over time, she purposely selected strategies to match the task at hand and this allowed her to achieve success. Patricia was confident in her ability in science as indicated by her positive self-efficacy. Patricia perceived that the GTSP involved too much *differentiation*.

CHAPTER 9

DISCUSSION

The aim of this discussion chapter is to draw all the findings of the research together, interpret them in light of literature, such that conclusions can be drawn and recommendations made. The discussion explores four themes: the nature of the gifted and talented science program: students and learning; assessment; and factors that affect achievement. At the close of the chapter a conceptual model that integrates the various themes of the research is presented.

The Nature of the Gifted and Talented Science Program

In constructive alignment, all critical components of a teaching context are integrated towards deep learning (Biggs, 2003). A tight fit between the needs of the gifted and talented and the classroom environment will facilitate optimum motivation (Turner & Meyer, 1999) and influence social and academic goals (Mansfield, 2001). Thus constructive alignment can influence the translation of a student's gifts namely their potential in science, into talents as measured by achievement which is the aim of the Gifted and Talented Science Program (GTSP). In this section the nature of the GTSP and its students are explored.

Student Selection

The students in the GTSP had their natural abilities in the intellectual domain of science assessed by means of the Higher Ability Selection Test (HAST) administered by the Australian Council for Educational Research (ACER). Selection resulted in two classes: the Gifted and Talented (G&T) science class and the Accelerated Learning Program (ALP) class. Entry into the classes was decided predominantly on the basis of the Mathematics component of the HAST. The cut offs were standardised scores of 58 and above for the G&T class and 51-57 for the ALP class.

A gifted student lies in the top 10% of the population (Gagné, 2006). Only those students in the MHS locality, whose parents perceived their child had exceptional natural ability, sat the HAST. It is therefore impossible to say if all the students selected were truly gifted in relation to other students in the state of Western Australia, however they were the students with the greatest science potential in the sample assessed by the HAST entering MHS in Year 8. Ultimately it is the role of the gifted and talented program coordinator to decide in any one year if one or two GTSP classes are warranted on the basis of the HAST results.

Students in the G&T class remained with the same teacher for two years, however there was some change to the composition of the class as some students left the school, the program or entered the G&T class.

Provisions

The Researcher was a participant observer in the G&T class during Term 1, 2007. Evidence from classroom observations indicated that teaching was designed to suit the G&T clientele. Teachers were selected to teach the GTSP classes on the basis of their constructivist approach. Rather than assume the students were empty vessels, or homogeneous, and come to class with a 'one size fits all' list of objectives to cover, the constructivist teacher pretests to determine prior knowledge and skills and builds a lesson from there (Wandersee, 2001). Such pretesting forms the basis of compaction and differentiation of the curriculum for gifted and talented students (Macleod, 2005; Smee, 2005; Van Tassel-Baska & Stambaugh, 2006).

Within the GTSP, classroom observations verified that formal and informal pretesting occurred in the G&T class of the GTSP (KF 4.2). Pretesting enabled the teacher of the G&T class to focus on the students' needs by differentiating the curriculum. The teacher was observed using her understanding of Bloom's taxonomy to further differentiate the curriculum for students of different abilities by providing opportunities for individuals to extend their thinking (KF 4.2). The teacher's ability to match the needs of the learners by asking questions at an appropriate level of complexity ensured students were challenged (Macleod, 2005; Plowman, 1980; Pritchard, 2005; Smee, 2005). This highly skilled teacher's differentiated questioning allowed students to work within their zone of proximal development. An emphasis on questions pitched at the higher levels of Bloom's taxonomy exposed the students of the G&T class to a greater percentage of higher order questions than might be considered the norm in mainstream classes (Feden & Vogel, 2003; Macleod, 2005) (KF 4.2).

Rather than focus on low order repetitive tasks and recall, the teacher of the G&T class provided opportunity for student lateral thinking and metacognitive tasks to promote self-regulation (KF 4.2). Thinking about thinking is a powerful tool in learning. Once a link is made between strategy and outcome, success follows (Ames, 1992b; Shi, Wang, Wang, Zuo, & Liu, 2001). Assigning success to appropriate strategy and effort, rather than innate ability, is a characteristic of deep learners. However, learning strategies need to be practised over time and to be effective strategies must be aligned to specific tasks. GTSP Teachers only see their students four times a week and it may be several months before a powerful strategy is used again. It may therefore be several years before a student learns to use a strategy autonomously. A student observed while the Researcher was conducting participant observation (Year 9, 2007) chose to draw a Venn diagram in a situation requiring compare and contrast in a Year 11 test marked by the Researcher. This was two years after she had first been introduced to the cognitive organiser.

The science curriculum at MHS is very packed. In addition, the need for teachers to assess and to report on the students' conceptual understanding and their ability to investigate scientifically compounds the problem, as a truly open investigation can take several weeks or longer to complete. Time spent on investigations thus reduces the time which can be spent on conceptual outcomes. At MHS each of the four conceptual outcomes of the Western Australian Curriculum is reported on once a year, using the results from common assessment tasks (CATs) to rank the students. It is only by the process of compacting the regular curriculum that GTSP teachers can provide time for extension work. G&T students grasp a science concept more quickly than their mainstream counterparts (Macleod, 2005; Taber, 2007b), pretesting allows a teacher to assess prior understanding (KF 4.2). Teachers need to be mindful of the selection of curriculum content to cover. Teachers who chose to leave material out of the intended curriculum do so at their peril as CATs require thorough recall of an extensive sample of material on the syllabus (KF 4.2). GTSP teachers therefore are put under pressure to juggle the need to cover the standard curriculum with the need to provide extension for the GTSP students.

When the GTSP was first conceived at MHS there were no formal examinations in lower school (Years 8-10). Thus compacting and differentiating the curriculum allowed time for more extensive authentic tasks (Macleod, 2005; Smee, 2005; Taber, 2007b; Van Tassel-Baska & Stambaugh, 2006). The demands of examinations held twice a year from 2007 onwards effectively reduced the time that GTSP teachers could spend on such tasks. Consequently, during the period of observation (Term 1 Year 9) although there was evidence of students beginning research to apply to a real-life scenario (Lesson 28, 22/3/2007) they did not complete a major authentic task. This situation was a cause of frustration to the teacher and the students alike (KFs 4.2 & 4.7).

Milieu

The GTSP aims to extend the students' understanding of science, but further than this, it aims to develop practices that facilitate life-long learning. Within the GTSP the social context has been manipulated by placing students with similar science potential together to facilitate high level thinking during social interactions (KF 4.1). When gifted students are placed together in a select class many more opportunities to learn from significant others exist than if gifted students are placed with students in mainstream classes (Macleod, 2005). High level thinking and acquisition of skills occur in classrooms when students interact with each other and their teacher. During participant observation, for example, a student was observed teaching a peer about photovoltaic cells as an aside during a research activity (KFs 4.1; 4.2 & 8.1; Lesson 28, 22/3/07; Macleod 2005).

Literature advocates the use of classroom environment measures in evaluations of programs, however, rarely in education are the perceptions of the students monitored (Dorman, 2002; Fraser, 1994). Students entering the GTSP had specifically chosen the program over mainstream classes because they, or their parents, felt the program would provide a learning environment that would better meet their needs. Consequently it was important to survey how well the students' preferred and actual perceptions of the classroom environment were aligned. To conduct person environment fit research, students' perceptions of the GTSP environment were assessed using results of a revised Individualised Classroom Environment Questionnaire (rICEQ).

When perceptions of the preferred and actual classroom environments were compared for students in the Year 8 G&T class, significant differences were found in the *Independence* and *Investigation* domains (KF 4.3). Children entering Year 8 have a natural inclination for learning science by inquiry. The mystique of the science laboratory and the chance of blowing something up, or at least burning something, are great motivators. Often the first introduction to science for students at high school comes on a Year 7 transition day where the science teachers pull out all the stops to entertain the students with hydrogen balloons and the like. The reality of science in a large high school is that not every science lesson takes place in a fully equipped laboratory. Practical work takes time and effort to organise and teachers are well aware of the safety aspects of experiments to be conducted by Year 8 students. Some of the research questions, put forward by budding pyromaniacs for open-ended investigations, are quickly extinguished by their teacher due to safety considerations. Science investigations are therefore carefully orchestrated to reinforce skills, in the context of the science concepts being taught at the time, with the resources available in the school. A period of practical science ends with the student writing up a practical report, often under test conditions, which is used to provide data for assessment and school reports. Consequently, the allure of science practical investigations for Year 8 students often wanes.

Significant differences were observed between the preferred and actual learning environments of Year 8 students in the GTSP in the *Independence* dimension of the rICEQ (KF 4.3). Students wanted more autonomy, however, they had yet to appreciate why teachers asked them to work outside their friendship groups or to sit in a predetermined seating plan. The amount of autonomy provided by the teacher in learning tasks varied. Participant observation confirmed that the teacher of the G&T class provided for a degree of flexibility in the demonstration of outcomes (KF 4.2). On most occasions the students in the G&T class were allowed to present their work in the way that best suited their learning style (Participant Observation, Term 1, 2007).

Perceptions of students in the ALP class indicate statistically significant differences between actual provisions and student expectations of differentiation of the curriculum as measured by the *Differentiation* dimension of the rICEQ (KF 4.3). Similar teaching resources were used in the ALP and G&T classes of the GTSP. These resources were generated to suit the needs of the students within the GTSP and were not used for the teaching of heterogeneous mainstream classes. It may be that since the students were all provided with the same text and generally the same tasks, they were unaware of the times that the teacher included differentiated activities. Meeting the needs of individuals can be done in subtle ways by a teacher with rich pedagogical content knowledge (Loughran, Berry, & Mulhall, 2007). Participant observation of the G&T class revealed strategies being used to extend the learning of each individual. For example, the use of a single graphic organiser such as a concept map can differentiate the learning for each student. When a teacher sets the construction of a concept map, whilst it might appear on the surface that each student is completing the same task, in reality each student is afforded an opportunity to demonstrate their unique understanding of the complexities of a concept and the interrelationships between subordinate concepts (KF 4.2; Lesson one, 1/2/07; (Roth, 1999).

In Year 8 the perceptions of the classroom teachers of the G&T and ALP classes were also measured using the rICEQ. The teacher of the G&T class was a more experienced teacher who had taught in the GTSP since the program began. As the G&T coordinator she was very aware of best practice pedagogy for the gifted, as such her ideal class was reflected in her very high scores on the preferred rICEQ measure (KF 4.4). The scores for the ideal classroom for the ALP teacher were much lower (KF 4.4; Table 4.4). This teacher was teaching in the GTSP for the first time and had not yet had access to targeted professional development relating to meeting the needs of the gifted. Throughout the year each GTSP teacher was presumably aiming to teach classes in a way that minimised the differences between their own preferred and actual scores.

Seemingly the teacher of the ALP class met with more success, as there was less variation between her preferred and actual classroom environment scores. This was possibly due to the fact that she had not set such lofty goals for her GTSP classroom practice. However, her preferred scores suggested she was working to reduce the degree of *Independence* in her classes, which was at odds from the wishes of her students who wanted more *Independence* (KFs 4.3 & 4.4; Table 4.5).

The teacher of the G&T class noted quite marked differences between her own preferred and actual classroom environment in Year 8. However, her students were quite happy with the environment in the G&T class and expressed a preference to continue with her as their teacher into Year 9 (KF 4.7).

GTSP students' perceptions of their ideal learning environment did not change significantly in Year 8 (KF 4.5), but by Year 9 differences were noted. In Year 9 the G&T class student preference for *Investigation* declined significantly. The Year 9 ALP class student preference for *Independence* and *Participation* both increased significantly from Year 8 levels (KF 4.6).

Assertion 9.1

The provision of special programs for the gifted and talented such as the GTPS facilitates learning by putting like minded individuals in the same class. The teacher of the G&T class was required to balance the requirements of the MHS science curriculum and assessment regime used for the purpose of ranking students against the best practice model for education of the gifted in science. She pretested and then compacted and differentiated the regular curriculum, her pedagogical skill allowed further differentiation 'in the moment'. GTSP lessons were purposefully designed to promote higher order thinking and metacognition. Ultimately the time constraints due in part to the MHS assessment regime limited the extent to which the GTSP students were involved in extension activities such as authentic tasks which are advocated as an important part of best practice for the gifted and talented.

Assertion 9.2

A student's perception of their ideal classroom is subject to change in the long-term; shaped by their past experiences, an assessment of their current teaching and learning needs and their expectations of the future. Whilst there was no significant change to the preferred classroom environment of students in Year 8, significant changes were seen between Year 8 and Year 9. In the G&T class, using the class as the unit of analysis, students' preference for *Investigation* declined, this was likely the result of the requirement to write-up each investigation. At MHS these write-ups provided data used for the purpose of reporting students' achievement in the investigation outcome. In the ALP class students' preference for both *Participation* and *Independence* increased. This was likely due to the more restrictive nature of the teaching within the ALP class. Maturation must certainly factor into changed perceptions, however the effect of stage of development on perceptions of classroom environment was beyond the scope of this research.

Students and Learning

The GTSP aims to foster in the students those intrapersonal characteristics that are likely to facilitate optimal translation of gifts into talents. An optimally gifted student will exhibit a deep approach to learning, have a high but not inflated self-efficacy, focus on problem solving, be strategic and self-monitoring and will seek assistance (Patrick, Gentry, & Owen, 2006). This section investigates the degree to which the GTSP promoted the development of these intrapersonal variables.

Learning Approach

One aim of the GTSP is to foster a deep approach to learning by engaging students in activities that require more than just memorisation of facts. Research indicates that you cannot teach a student to be a deep learner when the educational context is rewarding surface learning (Ramsden, 2003). Consequently, within the GTSP, strategies for promoting thinking at higher levels are utilised and the importance of students engaging with tasks at higher levels of thinking is underpinned by the actions of the teachers.

At the time that this research was conceptualised, it was decided that using change in learning approach as a means to assess the effectiveness of the GTSP as an educational context would be valuable. The Learning Process Questionnaire (LPQ) appeared to be a viable measure to determine learning approach and normative data were available which hypothetically made it possible to categorise a student's learning approach as deep, surface or achieving (Biggs, 1987a).

Research suggests that approach to learning is stable for some students; however, learning approach may alter with time depending on the learning context (KFs 8.2 & 8.4). Study orchestration prevails when students adapt their learning approach to their perception of what is required (Biggs, 2003; Prosser & Trigwell, 1999; Ramsden, 2003; Schmeck, 1988) (KF 8.3). In a survey of Australian schoolchildren aged between Years 8 and 11, Biggs (1993) found that using the class as a unit of analysis both surface approach and deep/achieving approach scores declined, more so for boys than girls. This decline indicated a reduced preference for either learning approach. However, Biggs concluded that such effects could be overcome by creating a good affective and cognitive learning climate.

To view the extent to which the GTSP affected learning approach, the LPQ was used to track the learning approach of all consenting students in the GTSP over two years. Data analysis however, was complicated by the lower consent rate of students in Year 8 compared to Year 9; the number of students moving into and out of the GTSP and students moving between classes of the GTSP for the start of Year 9 (see Chapter 3). However, data analysis did indicate a change in learning approach, using the class as the unit of analysis. Whilst not statistically significant, the students' surface approach scores increased over time (KFs 8.2 & 8.3). The students' deep approach scores showed an increase in Year 8, but then scores on this dimension started to decline in Year 9. In the ALP class this decline resulted in a final Year 9 score on the deep approach dimension lower than when the students entered the program in Year 8. The GTSP students' achieving approach scores also declined, furthermore the decline in achieving approach scores for students in the ALP class over the two year period was found to be statistically significant (KF 5.1).

It appears that study orchestration was in operation as outlined in the literature (Biggs, 2003; Prosser & Trigwell, 1999; Ramsden, 2003; Schmeck, 1988). Goal theory suggests that in order to motivate students to learn, the classroom climate, curriculum, instruction and assessment practices must be aligned in order to encourage a deep learning approach (Ames, 1992a; Ames & Archer, 1988; Brophy, 1999; Meece, 1991; Meece, Blumenfeld, & Hoyle, 1988; Urdan, Kneisel, & Mason, 1999). Contrary to the aims of the program, the GTSP students' deep learning approach scores did not increase over time. Previous sections of this Chapter have highlighted aspects of the classroom climate, curriculum and instructional practices which play a role in shaping students' approach to learning. Assessment practices will be outlined in a following section.

Self-Regulation

Self-regulation is not acquired but "shaped and elaborated through participation in 'zones of proximal development' according to the tenets of sociocultural theories" (Paris & Paris, 2001, p. 96). Research shows that students' conceptions of learning and use of self-regulatory learning (SRL) strategies vary according to the educational context (Purdie, Hattie, & Douglas, 1996). Scaffolding allows a student to carry out a task that they were not initially able to achieve independently and enables them to achieve a similar task independently (Roth, 1999).

Research by Hattie, Biggs and Purdie (1998) found that integrating the informed use of study strategies aligned to content and used for near transfer in context, was particularly useful with high ability students. Research by Ames and Archer (1988), with academically advanced students exposed to a study skills program, indicates that the perception of a mastery oriented classroom is crucial to students adopting adaptive SRL strategies.

The environment within the GTSP was structured to facilitate the development of students' self-regulation. The development of strategies that assist students to be autonomous learners requires the sustained and purposeful efforts of the classroom teacher. The teacher of the G&T class treated students as partners in the learning situation. She acted as a facilitator of learning and whilst she modelled strategies that students could use, furthermore, she also allowed the students choice. For example in discussing note-making formats, she discussed a number of alternative modes but then left the students to make up their minds as to which note-making style suited them (KF 5.2).

One type of self-regulatory cognitive learning strategy involves management of resources such as study time, environment and management of others (Pintrich & Schrauben, 1992). Most of the GTSP students interviewed were already structuring their environment to assist learning; their parents played a role in providing quiet study areas within the home (KF 5.3).

Help-seeking is a feature of students who self-regulate. Students who relate well to their teacher and who perceive that their teacher is involved with their learning are likely to engage more readily and ask questions in class. Cooperative learning, a feature of the G&T class, also facilitates help seeking (Ryan & Patrick, 2001). Rehearsal of answers with peers facilitates a safe classroom environment (KF 5.2; Lesson one, 1/2/07). Within the G&T class students perceived their teacher to be one that was concerned about them as individuals as indicated by the students' perceptions on the *Personalisation* dimension of the rICEQ (KF 4.3).

Classroom goal orientation also has an effect; help seeking being more likely where mastery is emphasised rather than performance (Ames, 1992b; Ames & Archer, 1988; Newman & Schwager, 1992). At no stage during participant observation was the ranking of students disclosed to the class although the G&T teacher provided feedback to parents when there was any concern with learning using the school diary and by telephone (Participant observation, Term 1 2007).

It was evident from interviews that, as stated in the literature, G&T students generally seek more assistance from adults, particularly parents, than age related peers (Zimmerman & Martinez-Pons, 1990). The parents of the students in the G&T class were supportive of their children's education process at MHS since they had actively sought a special educational program for them. Thus the parents had a significant, direct impact on their children's self-regulation and an indirect effect on their academic achievement (Maehr & McInerney, 2004; Zimmerman, 2004). At interview, many students reported that their parents and siblings were quite knowledgeable in the science area; as such they were able to provide assistance with homework and science projects when required. Those students who felt this type of support was lacking, relied on the classroom teacher and more knowledgeable peers for assistance (KF 5.3).

GTSP students used different cognitive strategies for different tasks. Examples of cognitive strategies were: rehearsal (reading aloud, highlighting text), elaboration (paraphrasing, summarising, creating analogies, generative note-taking, explaining ideas to someone else, question asking and answering) and organisational strategies (selecting the main idea, outline of material to be learned, concept mapping) (Pintrich & Garcia, 1991) (KFs 8.1; 8.2; 8.3 & 8.4).

The G&T teacher introduced several cognitive organisers during the period of participant observation (KF 5.2). Since research indicates it takes about two months and 10 constructions for a student to feel comfortable with using a particular scaffold (Wandersee, 2001), it appears that the students may need much more exposure to such organisers before they will use them autonomously. Literature suggests that during the performance phase of self-regulation, students use cognitive learning strategies to improve outcomes (Zimmerman, 2004). Subsequently they use a process of strategic outcome monitoring to monitor the effectiveness of their implemented strategies with respect to learning outcomes (Zimmerman, Bonner, & Kovach, 1996). If students perceive an organiser to be effective to achieve the task demands they will continue to use it. As a consequence of strategic outcome monitoring some students shunned more elaborate organisers which required higher order thinking (KFs 8.2 & 8.3; (Biggs, 2003).

Interview A which occurred midway through Term 1 Year 9 probed the use of self-regulatory learning strategies used by students in preparation for the CAT. Little was being done by the GTSP students to review their study notes in preparation for assessment. Long term planning to prepare for assessments was not evident. Since CATs took place within the school term, notification by the teacher a week prior to assessment was used by the students as a cue to begin revision. Few students thought to do more than shallow preparation that suggested a surface approach to learning. Since CATs were based on the text, most students relied solely on making notes based on the solitary text for test preparation and on memorisation of facts. It was only the deep/achieving learners who read with the intention of adding to their personal constructs, rather than reading to memorise facts (KFs 5.3; 8.1; 8.2; 8.3 & 8.4).

Metacognitive tools help students monitor their state of thinking with respect to the subject matter. Drawing a concept map forces the learner to consider the links between related elements of a phenomena and brings the links into consciousness which broadens understanding (Lochhead, 2001). A great deal of training is required before students can use concept maps proficiently as the complexity of such maps makes it difficult for the student to access the relationships and use the map effectively (McInerney & McInerney, 1998). The students interviewed had an aversion to the use of concept maps (KFs 5.3 & 8.1; Student Interview A), perhaps because many of the G&T students have the ability to recall facts and make interconnections between them readily, as evidenced by their levels of achievement discussed in a following section of this Chapter. It is through metalearning that students select the appropriate strategies for their learning context (Biggs & Moore, 1993). The value of developing deep learning strategies is being undermined by current assessment practices at MHS. Whilst it would likely be beneficial for G&T students to develop their repertoire of cognitive organisers in anticipation of future needs, the predominant assessment practices at the time of this research, namely the CATs, did not necessitate this.

The hypothetical assessment task presented to the students by the Researcher during Interview B in Term 1 Year 9 indicated that deep learners were able to analyse the requirements of the task more effectively and draw on a greater range of strategies aligned to the task than surface learners. Surface learners appeared more focused on the aesthetics of presenting information that they had ready access to, whilst deep learners engaged with logical argument, justification of facts and debate (KF 5.4).

The hypothetical task also prompted students to think about how organisers might be used to assist them in completing the assessment. The students were not yet able to link strategies with the task at hand without prompting (KF 5.4). It appears more needs to be done to assist the students to learn when and why to use a particular organiser. Students at MHS have just four science periods a week. Unless the student was encountering an organiser in subjects other than science across the school, it is unlikely that a single organiser would be used sufficiently in a year such that they would feel comfortable adding this strategy to their toolkit for autonomous use. A teacher's conditional knowledge in relation to the use of cognitive organisers comes from years of experience. Perhaps the teacher might use a think aloud protocol when modelling an organiser to make her conditional knowledge accessible for her students. This modelling would promote the near transfer in context advocated by research with high ability students (Hattie & Purdie, 1998).

It appears study orchestration can be adaptive or maladaptive. Evidence of adaptive study orchestration was seen in relation to the hypothetical task. During interview students were able, albeit with some prompting, to discuss how complex organisers were aligned to completion of the task. The suggestions made were at odds with the strategies they had accessed to prepare for the CATs (Biggs, 2003; Prosser & Trigwell, 1999; Ramsden, 2003; Schmeck, 1988). Thus one can conclude that in the GTSP it is vital that the assessment practices are aligned to encourage a deep learning approach (Ames, 1992a; Ames & Archer, 1988; Brophy, 1999; Meece, 1991; Meece, Blumenfeld, & Hoyle, 1988; Urdan, Kneisel, & Mason, 1999).

Self-Efficacy of Learning

Self-efficacy of learning involves internal comparisons, when students compare their performance in a subject with their performance in other areas, and external comparisons when they compare their performance with that of their classmates (McCoach & Siegle, 2003). In general, gifted students are more accurate at gauging their efficacy than regular learners (Pajares, 1996). Research has found that student giftedness is generally associated with high levels of academic self-efficacy (Hong & Aqui, 2004; Zimmerman & Martinez-Pons, 1990) (KF 8.1) but that students' perceptions of their academic ability decline as they proceed through school (Nicholls, 1984). A high sense of self-efficacy affects the forethought, performance and self-reflection phases of SRL through student use of more effective cognitive and metacognitive strategies (Schunk, 1991; Schunk & Pajares, 2004; Zimmerman, 1989a; Zimmerman, Bonner, & Kovach, 1996; Zimmerman & Martinez-Pons, 1992). The academic milieu of the GTSP is likely to affect students' feelings of self-efficacy and their use of SRL strategies (Zimmerman & Martinez-Pons, 1990). Highly gifted students can fail to reach their potential in circumstances where their perceptions of their self-efficacy are compromised (Bandura, 1997).

The students' perceptions of how well they were equipped to achieve in science were measured by their feelings of self-efficacy in learning. Time spent in the GTSP equated to a slight drop in feelings of efficacy in line with research that found that students' perceptions of their efficacy decline as they proceed through school (Nicholls, 1984). This decline is likely to be due to external comparisons (McCoach & Siegle, 2003) since the majority of assessments were norm-referenced and comparisons with others occurred. The reporting of a student's rank in high stakes measures through school reports, allowed external comparisons affecting perceptions of self-efficacy. It was not the practice of the G&T teacher to disclose the rank of individuals in class assessments. Teaching of appropriate learning strategies and articulation of what was required to achieve in assessment, in a non-competitive classroom environment, would likely increase the students' feelings of self-efficacy over the two year period. External comparisons made possible by ranking data from the results of tests such as the MSE Science Test and the National Chemistry Quiz (see Chapter 6) would likely produce changes in students' perceptions of their efficacy depending on their levels of achievement.

Also students entered Year 8 from feeder primary schools where they were likely to have been the top student. In high school, particularly within the GTSP, there can only be one top student. Comparisons between students' achievement were likely to have resulted in some students' lower perceptions of their self-efficacy. Despite this, the academic self-efficacy of the students in the G&T class was greater than that of students in the ALP class (KF 5.5).

Assertion 9.3

The changes in learning approach of GTSP students, using the class as the unit of analysis, indicate that still more needs to be done to promote a deep approach to learning, as deep approach scores declined and surface approach scores increased over time. Furthermore, where students have lost their desire to persist in applying themselves to a set task, as indicated by a diminishing achieving approach, it follows that they will not achieve to their full potential. Accordingly, the GTSP students' journey from gift to talent will be stymied.

Assertion 9.4

There was evidence to suggest that students were using a wide range of self-regulated learning strategies within the G&T class. The students selected strategies that they perceived were aligned to the task demands and allowed them to demonstrate achievement at high levels. The nature of the SRL strategies selected for preparing for the CATs and the hypothetical authentic task varied as the cognitive demand of the tasks was different. Long term planning for the CATs was not evidence as the students were experiencing high levels of achievement using minimal revision. Since the classroom teacher stressed mastery over performance, the students were comfortable to seek help from her.

Assertion 9.5

A range of cognitive organisers was presented in class and modelled by the G&T teacher. When directed, students were able to use these cognitive organisers. However, most of the students were not familiar enough with the organisers to choose to use them autonomously.

Assertion 9.6

Students in the G&T class had a higher perception of their self-efficacy than students in the ALP class. Students achieving high level academic outcomes had higher levels of self-efficacy than their peers. Even though the teacher in the G&T class did not provide students with ranking data, students had access to a range of performance data through which they could compare their performance against that of their peers. These comparisons impacted on the students' perceptions of their self-efficacy.

Student Achievement

Within the GTSP evidence of the students' achievement was determined from their results on international, national, state and finally school assessments. The following sections first discuss evidence of achievement in state and national tests and then on measures of science achievement at MHS.

Evidence of Achievement in State and National Tests

One's view of the purpose of assessment in education depends on one's perspective. At the level of an education system, assessment provides a means of ranking schools based on the measurable achievement of their students. As time progresses more and more funding in education is tied to schools showing evidence of value adding in relation to the achievement of their students in high stakes tests.

Apart from the provision of a special program for gifted students in science to meet the needs of the students, the GTSP provides the means by which MHS can ensure a high ranking in state-wide tests when compared against other schools. The ranking of schools, as reported annually in the Western Australian press, is based on the percentage of students from each school who achieve above 75% in tertiary entrance examinations at Year 12 level. In addition, the *My School* website developed by the Australian Assessment and Reporting Authority (ACARA) in 2010 allows parents to compare results on Australian national tests like the National Assessment Program Literacy and

Numeracy (NAPLAN) for students in lower secondary school. By attracting high calibre students into the GTSP, MHS has increased the chance of improving its rank against like public schools in published league tables.

If society and parents place an emphasis on test scores it can result in changes to a child's perspective of what they value in terms of their education. Such tension in assessment practices may result in constructive misalignment. To maximise a student's performance, a greater emphasis needs to be placed on formative assessment during the classroom teaching and learning process, rather than an emphasis on the results on standardised tests (Feden & Vogel, 2003).

Assessment also provides parents with information about their child's achievement, which can be used to validate their choice of school and specialist program for their child. A parent of a child who is gifted, will have their choice of program validated if they see evidence of superior achievement in high stakes tests. Consequently, MHS purposely enters GTSP students in several voluntary high profile national tests including the International Competition and Assessment for Schools (ICAS) Science Competition, National Chemistry Quiz and the Australian Mathematics Competition for the Westpac awards.

For external tests not based on the Western Australian curriculum, for example the ICAS, the focus of the test is on using rather than recalling knowledge. Consequently such tests are devised so than the question stem provides the contextual information necessary for the student to apply their understanding. As is the case with every school that enters students in competitions like the ICAS it is unlikely that students would have covered all of the background content required to answer every question. The MHS Year 9 GTSP students' results on the ICAS 2007 indicate relative strength in every question except one. GSTP students' results were about 20% above the state average. No areas of weakness were noted in feedback from the assessment unit of the University of New South Wales. The commendable results of the GTSP students were indicative of their strength in problem solving as reported by the board which set the test, GTSP results in this area were 60% above the state average (KF 6.1).

The results of the GTSP students in the National Chemistry Quiz were not as strong as those for the ICAS, only one area of strength was noted and two areas of weakness were highlighted. However, of note was that one student received a high distinction excellence award which is reserved for students in the 100th percentile. Whilst the Year 9 students had an average score 3.3% above the state average, the Year 10 students who sat the same paper achieved results 16.3% above the state average. Thus, one can conclude that to improve the results of Year 9 GTSP students on the National Chemistry Quiz, more exposure to Chemistry in Year 9 prior to the quiz is required. This will necessitate rearranging the Year 9 science curriculum, in effect to promote readiness for this particular competition (KF 6.2).

Students in the GTSP are also exposed to an enriched curriculum in mathematics. The students' achievement in mathematics was gauged by their results on the Australian Mathematics Competition for the Westpac Awards. The Year 9 students from the GTSP who sat the Australian Mathematics Competition obtained scores 19.7% above the state average for those students who selected to sit for this competition. MHS students showed particular areas of strength compared to state results. Problem solving was an area of strength where results were 60% above the state average. Therefore the HAST which was used to select students for the GTSP appears to be a suitable indicator of potential in mathematics (KF 6.3).

Assessments such as the Western Australian Monitoring Standards in Education (MSE) tests provide schools with a wealth of information that can be used by teachers to make curriculum decisions to best meet their students' needs. All students in Year 9 of secondary school across the state sit these tests. For tests based on the Western Australian curriculum, such as the MSE Science Test, each school's normal curriculum provides individuals with much of the content knowledge required to answer the questions set. However, the order of science topics covered in Year 8 and Year 9 will determine the concepts for which students will have been adequately prepared prior to the test. The science curriculum at MHS covers material from each of the conceptual outcomes each year, however, it should be noted that at the time of the MSE test students in Year 9 MHS had not yet covered the material pertaining to the Earth and Beyond; or Life and Living outcomes.

The science achievement of the students in the GTSP was commendable, as determined by their Western Australian Monitoring Standards in Education (WAMSE) scores for science. All but one of the students in the G&T class achieved results that were in the top 25% of the state. The average WAMSE score for the G&T class was 603. The average WAMSE science score of the state Year 9 cohort was 482 and Level 4 on the Western Australian Outcomes and Standards Framework. One criticism of the Western Australian MSE Science Test as a measure of achievement is that it fails to provide items that are capable of discriminating between students demonstrating high levels of achievement, in this case those who are performing at Level 5 on the Outcomes and Standards Framework and above. Achievement at Level 5 was demonstrated by obtaining a WAMSE score of 548 on the MSE Science Test. Ten of the G&T students were clustered right at the top of the results distribution with WAMSE scores of 632 or above. Such scores were well above the average WAMSE score for the G&T class of 603 (KF 6.4; Table 6.11).

A similar pattern of achievement for students in the GTSP was reflected in their WAMSE mathematics results. Since the HAST measures mathematical potential and assesses problem solving skills in the context of mathematics, one would expect that students selected for a special mathematics program would achieve high results in a state-wide mathematics test. All of the students in the top two MHS mathematics classes in Year 9 achieved results in the top 25% of students in the state. The average WAMSE mathematics score of the state Year 9 cohort was 536, Level 4. The Western Australian MSE Mathematics Test, like the Science Test, also fails to discriminate between high achieving students, again those performing at Level 5 and above. Achievement at Level 5 was demonstrated by obtaining a score of 573 on the MSE Mathematics Test. Nineteen of the GTSP students were clustered at the top of the results distribution with a WAMSE 714 or above. Seven of these students achieved perfect scores on the MSE Mathematics Test of 794 which highlights the need for certain items to be harder in order to provide conceptual challenge to these gifted students (KFs 6.4; 8.1; 8.4).

At the time of this research, WAMSE scores for science and mathematics were available to teachers for the cohort and to parents in the form of a formal report based on the achievement of their child. The advent of the *My School* website in 2010 has increased the importance of such tests in allowing education departments and parents to compare the results of like schools grouped using various indicators such as socioeconomic status of their student intake. As such, the likelihood of schools trying to ensure good results and value adding by advocating teaching to the test becomes more probable, especially if federal funding to schools is based on satisfactory performance in such tests.

Using the HAST as a selection test to identify students with potential in science and mathematics appears to have been successful. In all external measures of science achievement discussed, students in the GTSP were performing well above average for the state.

For the measures of science and mathematics achievement discussed earlier, assessment serves a purely summative function from the perspective of the student. Apart from a statement of results, which arrives several months after the test, the students get no other feedback that can be used formatively.

Evidence of Achievement at School Level

Teachers including those in the GTSP face a dilemma, "Concern for understanding competes with concern for covering the curriculum and testing what has been 'covered'" (Russell, 1993, p. 248). Research indicates that one of the most critical of influences on teaching and learning is assessment (Biggs, 2003; Ramsden, 2003). Teachers who attempt to stay true to their constructivist ideals are likely to face students that resist when they deemphasise assessment in favour of more meaningful learning (Russell, 1993).

The nature of assessment ultimately affected the provisions afforded in the GTSP. At MHS the fact that all students sat CATs shaped the actual curriculum. Learning programs were designed in eight week blocks to cover as much content related to a particular learning outcome as possible. An extra two weeks was assigned to investigation in every 10 week cycle. The CATs were based on material from the science text. Whilst higher order questions were included in CATs, familiarity with key content from the set text was essential. In order to demonstrate achievement on a task at Level 5 overall, a student needed to answer more than 80% of all questions from Level 2 to Level 5 correctly. To achieve Level 5 it was not sufficient to be able to problem solve and apply the understanding of a concept to a new situation, without base knowledge of the material from the text to answer recall questions a student's achievement was affected.

Much of the feedback about science achievement at MHS came from the students' results on these norm-referenced CATs as they were used to provide the data for reporting purposes. Almost without exception, students in the GTSP achieved A grades on their science reports. On occasions when a B grade was reported it was generally for the investigation outcome and was the result of a student failing to submit one of the completed practical write-ups on which the grade depended. The achievement of an A grade may well have indicated to a GTSP student that they were doing all they needed to succeed in science. GSTP student performance on the CATs and examinations held once a semester in Year 9 was well above the average for the cohort (KF 6.5).

During revision for the CATs, as a consequence of cognitive backwash, students did the minimum required to prepare. A cursory study of the relevant chapters in the text just prior to CATs, when cued by the teacher, was the revision strategy used by most students interviewed (KFs 5.3 & 8.3; Student Interview A). As long as they had an understanding of the content of the relevant chapters in the text, the students felt adequately prepared for the assessment.

The surface approach taken by students to assessment tasks manifested in changes to their LPQ scores. Over the research period both the G&T and ALP class increased their surface approach scores, decreased their deep approach scores and decreased their achieving approach scores (KFs 5.1; 8.2 & 8.3). Cognitive backwash likely explains the increase in surface approach seen within the GTSP. The students were employing more surface strategies as on reflection these appeared to be linked to their achievement of high grades in the CATs (Biggs, 2003; Ramsden, 2003). Whilst this study orchestration is likely to be detrimental in the long term, students in the GTSP were achieving success in all school science assessments (KFs 6.5; 8.2; 8.3 & 8.4).

The effect of assessment regimes affects the students' perceptions of the milieu in respect to the classroom environment as measured by the dimensions of the rICEQ. Increased assessment generally narrows the focus in classes to ensure essential content is covered reducing the extent to which the curriculum is differentiated. Time constraints affect the degree of student autonomy in the choice of learning activities and the extent to which they are actively engaged (*Independence and Participation*). Indirectly the stress of getting students ready for high stakes tests is likely to impinge on the way the teacher interacts with students, affecting perceptions of *Personalisation*. As practical investigations are time consuming, students may feel concerned when class time is used to complete such investigations at the expense of covering content related to key concepts (KFs 4.2; 4.3 & 4.6).

Cognitive backwash also affects teaching, as high stakes testing may result in teachers packaging the content according to what they think will be tested (Biggs & Moore, 1993). Contemporary cognitive science research encourages the study of fewer topics at depth to facilitate the development of scientific literacy as students construct conceptual relationships and deeper understandings (Curriculum Council, 1998; Treagust & Chittleborough, 2001; Wandersee, 2001). In the GTSP at MHS compaction of the curriculum frees up some time to devote to authentic tasks, which can then be used as a way of differentiating the curriculum (KF 4.2). Such tasks lead to a deeper level of student engagement as students have to have declarative knowledge, an understanding of concepts, as well as procedural knowledge which is the ability to use their understanding (Feden & Vogel, 2003; J. Gallagher, 1993; Pritchard, 2005; Van Tassel-Baska & Stambaugh, 2006). The time taken to prepare students to be successful in the CATs detracts from the time that can be spent engaging students with authentic tasks. In 2007 MHS introduced examinations held twice a year. This further compounded the issues surrounding the time taken for students to sit mandatory state and voluntary national testing. Furthermore, the number of teaching periods available to a teacher to extend the G&T students by using authentic tasks was reduced (KF 4.2). For able children and their teacher this situation is a conundrum.

Students in the GTSP are easily coping with the demands of assessments and tests at all levels. In the long term the assessment practices may not be eliciting the type of learning we would wish from our most able students. In order for students to be stretched, assessment for learning should be devised so that each child is challenged to learn in the zone of proximal development. At best the CATs and examinations were a means of sorting out how students were placed with respect to their peers. Even then the state-wide MSE test was unable to differentiate between the most able of students in science and mathematics. The assessment practices at MHS may not be setting our gifted students up for ultimate success in upper secondary school and university when the conceptual difficulty of the curriculum increases further.

Assertion 9.7

The results of state and national testing provided students with achievement data in relation to students beyond the school context. The state and national tests to which the GTSP students were exposed were all norm-referenced. School-based assessments provided students in the GTSP with a means to demonstrate their talent within the school context. The results of these assessments were reported by means of student grades on their MHS reports. The GTSP students demonstrated high levels of achievement on school-based and state level testing. There was variation in achievement between students on national and international level tests. However, in general results of the GTSP students were markedly higher than their peers as a result of their innate skills, particularly in problem solving. Weaker results were demonstrated by the Year 9 GTSP students compared to their peers on the National Chemistry Quiz due to the order of conceptual outcomes taught in Year 9.

Assertion 9.8

The time constraints that resulted from adhering to the norm-referenced summative assessment regime at MHS ultimately shaped the nature of teaching and alternative assessment practices within the GTSP. In particular the G&T teacher was not able to implement an authentic task as a means of formative assessment for every topic.

Factors Affecting Learning and Achievement

To determine which factors influence learning and achievement, correlation analyses were conducted in this research. In particular, analysis was conducted to examine the effect of learning approaches, the HAST and self-efficacy. The results of each of these correlation analyses are discussed in the following sections.

Learning Approach

Tests to determine correlation were performed for each of the learning approach dimensions against each of the measures of achievement sat by the students in the GTSP from national to school level. Whilst the literature discusses the link between deep approach and increased achievement (Ames & Archer, 1988; Maehr & McInerney, 2004; Meece, Blumenfeld, & Hoyle, 1988; Pintrich & De Groot, 1990; Pintrich & Garcia, 1991; Purdie, Hattie, & Douglas, 1996; Watters & Watters, 2007) no such statistically significant correlation was found in this study and this may have been influenced by the small sample size. Neither was the composite deep/achieving approach found to be of statistically significant benefit in terms of achievement. However, statistically significant negative correlations were found for a surface motive against achievement in all but MHS school-based measures, a further piece of evidence of the study orchestration seen within the GTSP (KF 7.1).

Statistically significant negative correlations were also found for surface strategy against all measures of achievement to which the GTSP students were exposed (KF 7.1). Accordingly, teacher reflection is advocated with reference to the extent to which they promote such learning strategies in class, either directly by their teaching strategies, or by subliminal messages the students may be receiving as a result of their perceptions of the type of strategy required to do well (KF 7.1). An achieving motive was found to be of significant benefit to achievement but only on MHS school-based measures. Additionally the use of achieving strategies was also found to be significantly adaptive in the school-based assessment context (KF 7.1)**.**

Testing at school, state and national level was predominantly by multiple choice items. The literature notes that with such multiple choice tests low quality learning is rewarded, which leads to superficial rote level processing strategies (Maehr & McInerney, 2004). The findings of this research are consistent with the literature in that the students' use of a surface approach increased over time (KF 5.1) presumably in response to a predominance of multiple choice tests. The dilemma is that such tests inculcate surface strategies, but the use of surface strategies does not correlate with higher achievement on any but MHS school-based measures (KF 7.1).

An achieving approach was not found to be adaptive for achievement in any state or national testing measures to which GTSP students were exposed. The failure of the achieving approach to be adaptive for national testing is likely be due to the fact that students found it difficult to decide on a strategy to prepare for tests such as the International Competition and Assessment for Schools (ICAS) Science Competition. Although students knew of the testing date in advance, no time was allocated for preparation in science classes prior to the test. Teachers had access to past ICAS papers, but since the science content covered by the test was diverse, sticking to the MHS science curriculum was considered necessary to make better use of class time. Ultimately, it was the inherent skills of the GTSP students in problem solving which allowed them to correctly answer even the most challenging questions on tests such as the ICAS. In such tests the question stem provides much of the background science required to ascertain the correct response for a student with substantial abstract reasoning skills (KF 6.1).

An achieving approach was however found to be adaptive in the MHS assessment context, where a high score on the related dimension of the LPQ correlated with high achievement (KF 7.1). When ranked against the other students in the MHS cohort, the students with an organised approach and a will to do well at their studies were more successful than others. The MHS assessments involved a certain commitment to the learning of content in addition to the ability to apply that knowledge to solve problems (KF 6.5).

The construction of the MSE Science Test was similar to the construction of the MHS based CATs in that it was composed of multiple choice and short response items. Yet no statistically significant positive correlation between an achieving approach and achievement on the MSE Science Test was found in this research. A possible explanation for this is that students were tested on material not closely aligned to the MHS science curriculum or to the science text they were using. In addition since the MSE Science Test was administered about half way through Year 9 some of the questions were based on science content to which the MHS students had not yet been exposed. The inability of the MSE Science Test to spread out the level of student achievement at the top end may also have played a part.

Assertion 9.9

Many of the assessment measures to which the GTSP students were exposed consisted of multiple choice items. These types of assessments are easy to administer within the constraints of time available in science lessons. However, the learning approach of students within the GTSP changed with time, the students increasingly using a surface approach. This is likely to be the result of study orchestration.

Higher Ability Selection Test

Tests for correlation were performed for the Higher Ability Selection Test **(**HAST) against all measures of science achievement. Statistically significant positive correlations were found between the HAST and school-level testing and between the HAST and state level WAMSE scores that were the basis of reported achievement on the MSE Science Test. In relation to national level testing on measures such as the ICAS and National Chemistry Quiz it appears the HAST is not such a good predictor of high achievement as no statistically significant positive correlations were found. The discrepancy between HAST score and achievement may be explained by the misalignment of MHS science curriculum and content covered by national tests particularly the National Chemistry Quiz as discussed previously (KF 6.2).

Assertion 9.10

The HAST has high predictive validity in respect to those high stakes measures of science achievement used to report of progress of students at MHS and within the state, namely the MSE Science Test (KF 7.2). Interestingly the HAST showed no positive correlation against the MSE Mathematics Test although there was a statistically significant positive correlation between the HAST and the Australian Mathematics Competition for the Westpac Awards. Further research is needed to examine this phenomenon (KF 7.3).

Self-Efficacy of Learning

If we assume that by virtue of the positive correlations found between the HAST and the results on the MSE, that the HAST is a suitable measure of giftedness in science, then it is appropriate to use the HAST in determinations of correlations between giftedness and self-efficacy of learning. Contrary to research in the literature that reported that student giftedness is generally associated with high levels of academic self-efficacy (Hong & Aqui, 2004; Zimmerman & Martinez-Pons, 1990), this research found no such statistically significant correlations (KF 7.4).

In accordance with previous research in the literature (Bandura, 1997; Hong & Aqui, 2004; Pajares, 2002; Zimmerman & Martinez-Pons, 1990) statistically significant positive correlations were found between self-efficacy and achievement in science. These positive correlations held for school level, state level and national level testing (ICAS) but not for the National Chemistry Quiz (KF 7.6).

Assertion 9.11

An anomaly of this research was the absence of correlation between student self-efficacy and the HAST which was the measure of academic potential used for placement of students within the GTSP (KF 7.4). However, high achievement did result in perceptions of high academic self-efficacy (KF 7.6).

Cross-Case Analysis of the Factors that Affect Learning and Achievement

Scrutiny of the research data using the science class as the unit of analysis has indicated patterns with respect to learning approach, classroom environment, self-efficacy and achievement. However, it has previously been acknowledged that to understand the essential elements of a successful program, simple input/output evaluation is not sufficient (Black, Harrison, Lee, Marshall, & Wiliam, 2002). The aim of this research was to illuminate the parameters of the black box, namely the GTSP, and to determine how it shaped the individual students within. To this end various sources of qualitative data were utilised in this mixed methods research.

Whilst it was initially conceived that an increase in deep approach to learning would be an indicator of success for the GTSP, many of the students' learning approach profiles were highly variable over time. Consequently, to determine the effect of the GTSP on individual students, survey data, participant observation, artefacts, achievement measures and two separate one-on-one interviews were analysed (see Chapter 8). The multiple sources of information allowed triangulation of data. The following cross-case analysis of the mediating factors that affect learning and achievement draws from all four case studies in Chapter 8.

The HAST as a Measure of Potential

The HAST appears to be an appropriate measure to determine giftedness in science. The HAST has a mathematics component which incorporates abstract reasoning, a comprehension section and a written language component Care needs to be taken when inclusion into the GTSP, or exclusion, is on the basis of a high score on the mathematics component alone. Students with high overall scores on the HAST are more likely to display higher achievement. As students progress through high school, high achievement within the GTSP depends on the correct interpretation of questions. Interpretation skills are more likely to be indicated by the HAST comprehension component than the mathematics component (Case One, Graham; Case Two, Matthew). Currently the mathematics component results are used predominantly to determine the G&T class, with other components considered for borderline cases.

Achievement

Achievement records may be used to indicate the success of the GTSP in general or as evidence of the translation of a student's potential into talent in the academic field of science. The level of achievement of three of the four cases studied is stellar (Case One, Graham; Case Three, Wade; Case Four, Patricia). However, rather than rejoicing, this should be the cause of some concern. In order to learn in the zone of proximal development a student needs to be placed in a learning context where they learn from significant others. In the context of the GTSP, for students such as Graham, Wade and Patricia, who showed evidence of achievement in the 98th to 100th percentile of the state on recognised tests of mathematics and science, the opportunity for learning will be limited by the complexity of the tasks at hand.

Within the GTSP the curriculum was constrained by the need to prepare students for the CATs and to an extent the MSE Science Test. Within the Year 9 cohort achievement at Level 4 is the acceptable achievement standard. In providing opportunities for students to access the mainstream curriculum, even in a compacted form, opportunities for appropriate differentiation of the curriculum were forfeited.

Providing students with opportunities to sit national and international tests of mathematics and science allowed students to engage with more challenging questions. Yet these tests were not constructed in a way that tested the students at the upper range of ability which indicates a lack of internal consistency for these measures. Certainly the MSE Science Test and MSE Mathematics Test failed to provide the cognitive challenge required to delineate between the most able students.

Demonstration of Achievement and Learning Approach

Contrary to literature (Hattie & Purdie, 1998) there does not appear to be a relationship between the ability to operate at abstract relational level and the learning approach of students in the GTSP. Wade (Surface Approach), Patricia (not categorised) and Graham (Deep/Achieving Approach) were all able to operate at this level. Matthew

(Surface Approach) was also able to respond to questions requiring abstract multistructural levels of engagement.

The LPQ measured learning approach at particular points in time. The students demonstrated outcomes at abstract relational level at different times. It is likely that the students matched their strategy to the task demands in the moment. As indicated by Biggs and Moore (1993) ability does have bearing on the use of different approaches and meta-learning does indeed affect learning approach through study orchestration.

Self-Regulation

An aim of the GTSP is to teach students to be autonomous in the use of self-regulatory learning (SRL) strategies. In order for students to develop adaptive strategies for learning they need to assess how effective their self-regulatory strategies have been in attending to learning tasks. The type of learning task to which the students are exposed therefore plays a key role in the development of SRL strategies.

The high academic achievement of the GTSP students was affecting the self-regulation phase of their learning. The type of strategies being viewed as adaptive for CATs were those aligned to a surface learning approach, such as memorisation. Students within the GTSP were able to achieve high level outcomes on CATs with minimal preparation. By reviewing several chapters of text in the week prior to a CAT, students were able to demonstrate outcomes at Levels 2, 3 and 4 with ease. Furthermore, it appears that the stem of the higher order questions in the CATs provided sufficient information to enable gifted students to apply their understanding and demonstrate Level 5 and 6 outcomes with relative ease.

The development of adaptive SRL strategies for more cognitively demanding tasks was being undermined by the assessment regime at MHS. Lack of engagement with concepts at an appropriate level of difficulty for students like Graham, Wade and Patricia limited their development of appropriate self-regulatory strategies to match the demands of complex tasks. Within the GTSP, as time permitted, authentic tasks were presented that provided an opportunity for students to engage with learning at a deeper level. However, unless prompted, only the deep/achieving students were able to successfully deconstruct the task demands and select the most aligned strategies for demonstration of higher order outcomes. Unless students have a quest for understanding they will default to using the strategy they perceive will adequately get the job done. This does not mean that gifted students do not have the ability to problem solve when the need arises. Each of the students defined as a case was reported to have strong problem solving skills by the University of New South Wales after the ICAS Science Competition. When provided with the background information required to answer a problem solving item they were able to utilise appropriate strategies.

Self-Efficacy

The educational context within the GTSP was providing the students with many sources of achievement data. Such data provided the students with evidence of the effectiveness of their learning strategies. Students who showed high levels of achievement with respect to their peers, namely Graham, Wade and Patricia had positive feelings of their self-efficacy. Students achieving lower levels of academic success, for example Matthew, had a lower perception of their self-efficacy. The self-reflection by students in relation to their strategy use and academic achievement had an impact on their perceptions of the ideal classroom environment.

Classroom Environment

The classroom teacher of the G&T class valued those practices that were aligned to best practice in gifted education. She strived to achieve her ideal classroom within the confines of the GTSP context at MHS.

Students in the G&T class were experiencing success without the expenditure of a great deal of effort. It is likely that this success had an impact on the students' perceptions of an ideal classroom. For students who were not deep/achievers, there was specifically a decline in their preference for *Investigation, Independence* and *Differentiation.* Furthermore, their preferences were at odds with those of their teacher.

A teenager has many demands on their time, if success can be achieved by narrowing the scope of one's study and relinquishing the control of the learning context to the teacher than this is what they come to prefer. Students with a surface or achieving approach considered the extra time required to memorise something a form of punishment. They did not appreciate attempts to differentiate the curriculum by working on individualised tasks that required research or application of knowledge. They also did not recognise the benefit of applying scientific method to problem solving by involving themselves in practical investigations. Again the investment of time taken to complete such practical work may have appeared counterproductive in terms of results.

Within the GTSP close alignment between the teacher and student perceptions of an ideal classroom environment was not always achieved. It was the deep/achieving learners such as Graham that held perceptions of an ideal classroom environment that came in time to mirror those of their teacher. Those with a deep approach saw value in participating actively in differentiated learning tasks that stretched the individual to capacity and involved application of knowledge in problem solving scenarios. They appreciated the opportunity to solve a problem through practical investigation. They also valued autonomy in learning.

Whilst the teacher strove to achieve her ideal classroom environment there was likely to be a mismatch with the preferences of the majority of her students as the results of LPQ survey determined that deep/achieving learners were in the minority in the G&T class. Although classroom fit research suggests teachers aim for alignment, here is a case for the teacher knows best.

Assertion 9.12

The selection of students into the GTSP using the mathematics component of the HAST resulted in some students entering the G&T class in Year 8 who subsequently did not perform well on all science assessment measures. Using the mathematics component of the HAST to select students also resulted in the exclusion of high performing students from the Year 8 G&T class. Exposure to assessment measures such as the ICAS and National Chemistry Quiz provided students with a higher degree of cognitive challenge than would have been experienced if students had only encountered school-based assessments. Evidence that students were achieving in the top percentile indicates that these measures still did not test the most able of the GTSP students. The ability to operate at abstract relational level was not related to learning approach for those students who had high level innate ability in science. They simply chose those SRL strategies they felt they were most adaptive to the task at hand. Students within the G&T class did not necessarily appreciate the extent of the differentiated activities that was afforded to them. Without an understanding of the benefits of a differentiated curriculum on their learning, students perceived that completing the same tasks as other class members was favourable.

Table 9.1 summarises the assertions drawn from the findings of this research. The table is organised according to the themes discussed in this study, namely the nature of the GTSP, students and learning, student achievement and factors that affect achievement.

Table 9.1

Summary of Assertions

Themes		Assertions
The nature of the GTSP	**9.1**	The provision of special programs for the gifted and talented such as the GTPS facilitates learning by putting like minded individuals in the same class. The teacher of the G&T class was required to balance the requirements of the MHS science curriculum and assessment regime used for the purpose of ranking students against the best practice model for education of the gifted in science. She pretested and then compacted and differentiated the regular curriculum, her pedagogical skill allowed further differentiation 'in the moment'. GTSP lessons were purposefully designed to promote higher order thinking and metacognition. Ultimately the time constraints due in part to the MHS assessment regime limited the extent to which the GTSP students were involved in extension activities such as authentic tasks which are advocated as an important part of best practice for the gifted and talented.
	9.2	A student's perception of their ideal classroom is subject to change in the long-term; shaped by their past experiences, an assessment of their current teaching and learning needs and their expectations of the future. Whilst there was no significant change to the preferred classroom environment of students in Year 8, significant changes were seen between Year 8 and Year 9. In the G&T class, using the class as the unit of analysis, students' preference for *Investigation* declined, this was likely the result of the requirement to write-up each investigation. At MHS these write-ups provided data used for the purpose of reporting students' achievement in the investigation outcome. In the ALP class students' preference for both *Participation* and *Independence* increased. This was likely due to the more restrictive nature of the teaching within the ALP class. Maturation must certainly factor into changed perceptions, however the effect of stage of development on perceptions of classroom environment was beyond the scope of this research.
Students and learning	**9.3**	The changes in learning approach of GTSP students, using the class as the unit of analysis, indicate that still more needs to be done to promote a deep approach to learning, as deep approach scores declined and surface approach scores increased over time. Furthermore, where students have lost their desire to persist in applying themselves to a set task, as indicated by a diminishing achieving approach, it follows that they will not achieve to their full potential. Accordingly, the GTSP students' journey from gift to talent will be stymied.
	9.4	There was evidence to suggest that students were using a wide range of self-regulated learning strategies within the G&T class. The students selected strategies that they perceived were aligned to the task demands and allowed them to demonstrate achievement at high levels. The nature of the SRL strategies selected for preparing for the CATs and the hypothetical authentic task varied as the cognitive demand of the tasks was different. Long term planning for the CATs was not evidence as the students were experiencing high levels of achievement using minimal revision. Since the classroom teacher stressed mastery over performance, the students were comfortable to seek help from her.
	9.5	A range of cognitive organisers was presented in class and modelled by the G&T teacher. When directed, students were able to use these cognitive organisers. However, most of the students were not familiar enough with the organisers to choose to use them autonomously.
	9.6	Students in the G&T class had a higher perception of their self-efficacy than students in the ALP class. Students achieving high level academic outcomes had higher levels of self-efficacy than their peers. Even though the teacher in the G&T class did not provide students with ranking data, students had access to a range of performance data through which they could compare their performance against that of their peers. These comparisons impacted on the students' perceptions of their self-efficacy.

Student achievement

9.7 The results of state and national testing provided students with achievement data in relation to students beyond the school context. The state and national tests to which the GTSP students were exposed were all norm-referenced. School-based assessments provided students in the GTSP with a means to demonstrate their talent within the school context. The results of these assessments were reported by means of student grades on their MHS reports. The GTSP students demonstrated high levels of achievement on school-based and state level testing. There was variation in achievement between students on national and international level tests. However, in general results of the GTSP students were markedly higher than their peers as a result of their innate skills, particularly in problem solving. Weaker results were demonstrated by the Year 9 GTSP students compared to their peers on the National Chemistry Quiz due to the order of conceptual outcomes taught in Year 9.

9.8 The time constraints that resulted from adhering to the norm-referenced summative assessment regime at MHS ultimately shaped the nature of teaching and alternative assessment practices within the GTSP. In particular the G&T teacher was not able to implement an authentic task as a means of formative assessment for every topic.

Factors that affect achievement

9.9 Many of the assessment measures to which the GTSP students were exposed consisted of multiple choice items. These types of assessments are easy to administer within the constraints of time available in science lessons. However, the learning approach of students within the GTSP changed with time, the students increasingly using a surface approach. This is likely to be the result of study orchestration.

9.10 The HAST has high predictive validity in respect to those high stakes measures of science achievement used to report of progress of students at MHS and within the state, namely the MSE Science Test (KF 7.2). Interestingly the HAST showed no positive correlation against the MSE Mathematics Test although there was a statistically significant positive correlation between the HAST and the Australian Mathematics Competition for the Westpac Awards. Further research is needed to examine this phenomenon (KF 7.3).

9.11 An anomaly of this research was the absence of correlation between efficacy and the HAST which was the measure of academic potential used for placement of students within the GTSP (KF 7.4). However, high achievement did result in perceptions of high academic self-efficacy (KF 7.6).

9.12 The selection of students into the GTSP using the mathematics component of the HAST resulted in some students entering the G&T class in Year 8 who subsequently did not perform well on all science assessment measures. Using the mathematics component of the HAST to select students also resulted in the exclusion of high performing students from the Year 8 G&T class. Exposure to assessment measures such as the ICAS and National Chemistry Quiz provided students with a higher degree of cognitive challenge than would have been experienced if students had only encountered school-based assessments. Evidence that students were achieving in the top percentile indicates that these measures still did not test the most able of the GTSP students. The ability to operate at abstract relational level was not related to learning approach for those students who had high level innate ability in science. They simply chose those SRL strategies they felt they were most adaptive to the task at hand. Students within the G&T class did not necessarily appreciate the extent of the differentiated activities that was afforded to them. Without an understanding of the benefits of a differentiated curriculum on their learning, students perceived that completing the same tasks as other class members was favourable.

A Conceptual Model of the Factors that Affect Learning and Achievement in the Gifted and Talented Science Program

The development of the following conceptual model has been informed by literature and the findings of this research. This multifaceted evaluation of a gifted and talented science program over a period of two years allowed the Researcher to further develop the conceptual framework presented in Chapter 2 (Figure 2.12).

The conceptual model (Figure 9.1) shows that a gifted student with potential in the academic field of science progresses on a journey towards talent, which is measured by academic achievement in the top 10% of their cohort. This journey is mediated by both environmental and interpersonal factors (Gagné, 2006).

The classroom environment is shaped by the teacher's preferred classroom environment, which is moulded in turn by the teacher's pedagogical content knowledge (Loughran, Berry, & Mulhall, 2007). The students' preferred classroom environment may also play a part in shaping the classroom milieu if the teacher is working towards alignment (Dorman, 2002; Fraser, 1994). In particular the extent to which learning is differentiated, the degree of student autonomy in learning, specifically independence, and the extent to which investigative work is promoted in problem solving will be considered by the teacher. The classroom dynamics are influenced by the actual students within the class. The curriculum within the classroom is determined by the context of the school.

The teacher employs their pedagogical content knowledge to deliberately select teaching strategies that will meet the needs of the gifted learner (Gross, 2005a; Loughran, Berry, & Mulhall, 2007; Macleod, 2005; Van Tassel-Baska & Stambaugh, 2006). In particular there will be a focus on cognitive and metacognitive strategy use in an effort to train students to be autonomous self-regulators of their own learning (S.M Reis, 2004; Zimmerman & Martinez-Pons, 1990). An understanding of the likely strategy demands of assessment tasks constructed both by the teacher of the gifted and talented and by other science colleagues will impact on the need to expose the students to specific strategies during the teaching process. Prior exposure to the relevant SRL strategies required for assessment tasks will determine the extent of achievement. The impact of whole cohort normative assessment as a constraint on differentiated assessment practices cannot be denied (Biggs, 2003; Feden & Vogel, 2003; Ramsden, 2003). It is through assessment that students demonstrate their talent. Evidence of very high achievement nonetheless should flag the need to further differentiate assessment to best meet the needs of the highly gifted.

Teaching strategies, assessment practices and evidence of achievement all have the potential to develop the intrapersonal catalysts of the students (Biggs, 2003). It appears that within the GTSP misalignment of assessment practices is related to changes in learning approach towards surface learning. The students' feelings of positive self-efficacy that result from high achievement are exacerbating this effect (Bandura, 1997; Schunk, 1991).

A student's learning motive and perceptions of their self-efficacy dispose them to engage with specific SRL strategies. The suite of strategies brought into play will be aligned to the student's learning motive. Through the mediating processes of metacognition and study orchestration, a student will come to use those strategies they feel necessary to feel efficacious in their learning context, particularly with reference to demonstrable evidence of personal achievement (Pintrich & Schrauben, 1992). Self-reflection on the adaptive use of strategies within the learning context, as students connect positively with tasks that integrate more cognitive challenge, can reconfigure a student's learning approach over time towards deep learning.

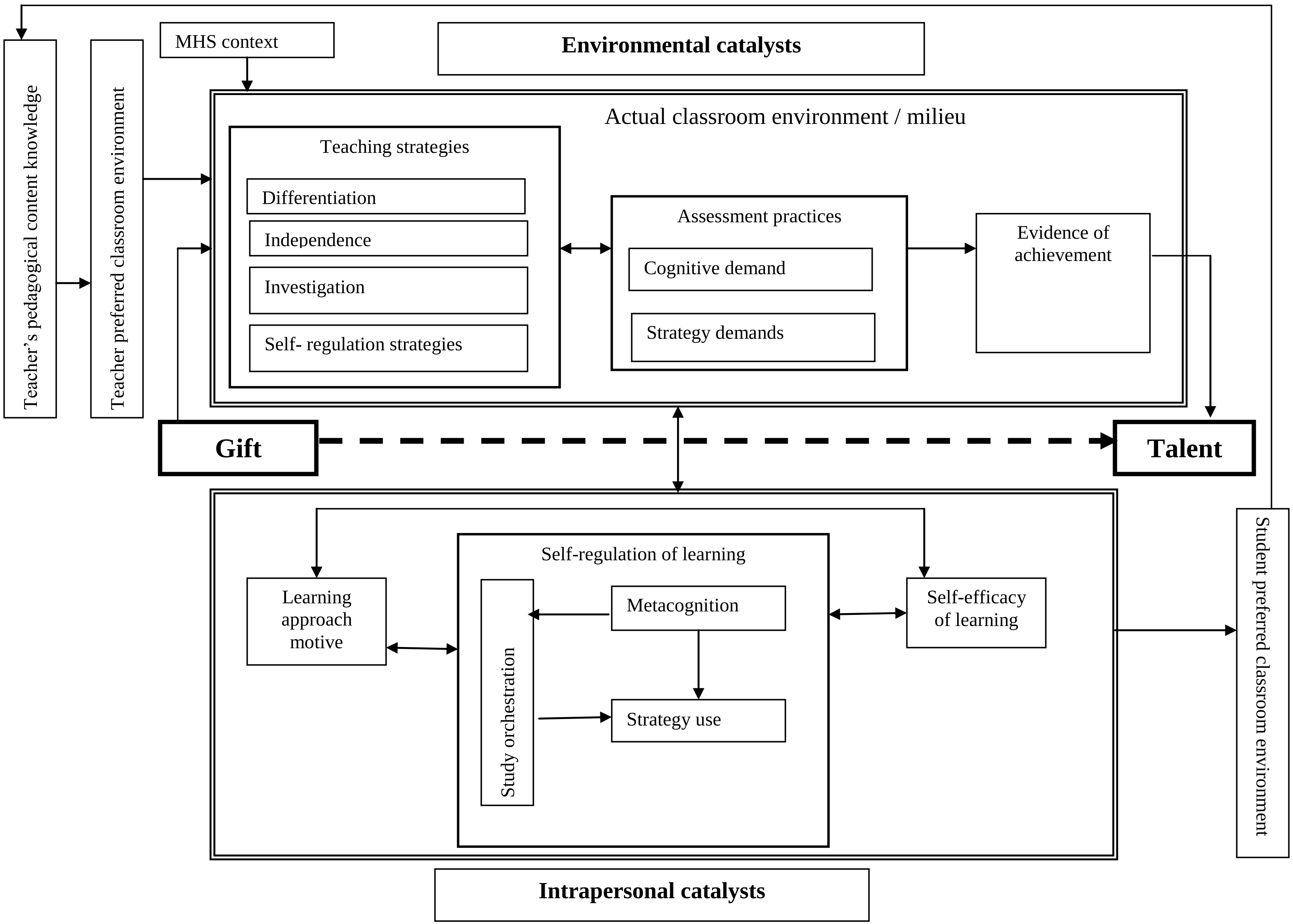

Figure 9.1. A conceptual model of the mediating factors that affect learning and achievement in the Gifted and Talented Science Program.

CHAPTER 10

CONCLUSIONS

In this chapter the aim is to draw on the assertions made in the discussion chapter and present conclusions prior to making recommendations that will impact on the teaching of gifted and talented students in science. The chapter is arranged so that conclusions in relation to each of the research questions are discussed in turn. The contributions of this research to the body of knowledge in the context of gifted and talented science education in secondary schools follow. The limitations of the study are then acknowledged. Implications for classroom practice borne out of the research data are detailed prior to suggestions for further research and a final reflection.

Conclusions

The conclusions of this research are grounded in the quantitative and qualitative data gathered over the research period. The data drove the identification of key findings. Interpretation of the key findings was the basis of the assertions (see Figure 3.2). The conclusions presented in this chapter are organised as responses to each of the research questions which were conceptualised at the commencement of this study.

Research Question One

What is the nature of the teaching and learning context within the Gifted and Talented Science Program at Metropolitan High School?

Students in the GTSP were placed in an optimal position to learn from knowledgeable others as being in a class with other gifted students enhanced social learning within their zone of proximal development. The HAST had high predictive validity for those measures of achievement that were obligatory for GTSP students, namely the MHS CATs and MSE Science Test (Assertion (A) 9.10). Teachers in the

GTSP balanced the requirements of the MHS science curriculum against the best practice model for education of the gifted in science. There was evidence of pretesting, compacting and differentiating the regular curriculum. GTSP lessons promoted self-regulation of learning in particular the use of cognitive organisers to facilitate higher order thinking and metacognition. However, the MHS assessment regime limited the extent to which the GTSP students were involved in authentic tasks (A 9.1). The students' perceptions of their ideal classroom varied over time based partly as a result of assessment of their ongoing teaching and learning needs (A 9.2).

Research Question Two

How and why do the experiences of students in the Gifted and Talented Science Program affect learning approach, self-regulated learning and self-efficacy of learning?

In general the GTSP did not appear to be increasing deep or achieving approach to learning. Assessment tasks were not promoting deep learning strategies. Furthermore, the GTSP students' surface approach scores increased over time (A 9.3).

Students were using a range of self-regulatory strategies such as structuring their home study area, seeking information and assistance, making and reviewing study notes and self-evaluating. Whilst the teacher of the G&T class promoted the use of cognitive organisers to facilitate the organisation and transformation of data, there was limited evidence of the autonomous use of such organisers by students (As 9.4 & 9.5). Use of tools such as the ICEQ allow teachers of the GTSP to assess the culture of the classroom in relation to a safe classroom environment that supports the self-regulatory strategy of help seeking (As 9.2 & 9.4).

Students were not confident in the autonomous use of cognitive organisers due to limited exposure. When a teacher models the use of a particular type of organiser this assists students to develop the conditional knowledge needed to select appropriate strategies during future tasks. However, teachers themselves need to be confident in their choice of strategy (A 9.5).

A true measure of the extent of one's self-efficacy is necessary to determine if one possesses the strategies required to achieve at high levels. Although external comparisons of achievement were avoided within the GTSP, results from norm-referenced measures of performance provided students with an indication of level of achievement of outcomes. Criterion referenced assessment rubrics provided a framework from which the students could identify how to improve the quality of their marks (A 9.6). The level of self-efficacy amongst GTSP students was high (As 9.6 & 9.7). Self-efficacy had strong correlations with most measures of science achievement (A 9.10).

Research Question Three

What evidence of achievement exists for students in the Gifted and Talented Science Program to suggest they are reaching their potential and demonstrating talent in the field of science?

It appears that students within the GTSP are demonstrating talent since they were able to demonstrate high levels outcomes in school, state and national measures of achievement. There was evidence to suggest that not all GTSP students were exposed to test items that challenged them optimally, particularly high achievers such as Graham, Wade and Patricia. All three of these students achieved results in the top two per cent on the International Competitions and Assessments for Schools (ICAS) Science Competition (A 9.12). The fact that many of the achievement measures were composed predominantly of multiple choice items meant that the GTSP students, who had strong problem solving skills, could demonstrate high achievement without engaging their higher order thinking skills to capacity (As 9.7 & 9.12).

At MHS assessment of learning is doing little to promote learning of students within the GTSP. More than any other factor, the summative assessment regime is impinging on the nature of teaching and learning within the program. Students with a planned approach to their studies continued to do well on school-based assessments. The achieving approach was seen to be adaptive at least in the MHS school context (A 9.9).

Research Question Four

Is there variation among students in the impact of their participation in the Gifted and Talented Science Program?

The GTSP provides a suitable teaching and learning environment for students selected by the HAST (A 9.10), but there is variation in the impact for individual students as a consequence of being placed in the program. Whilst the GTSP students have the greatest science potential within MHS, the class composition is still somewhat heterogeneous (As 9.3 & 9.7). In the process of selection, the use of the overall HAST score is advocated over the mathematics component. Both Graham and Matthew appear to have been misplaced at the start of Year 8 due to the selection mechanism used (A 9.12). To meet the needs of all GTSP students and facilitate the best educational outcomes, the balance of assessment needs to be tipped in favour of differentiated authentic tasks (A 9.8). Despite the value the G&T teacher placed on differentiated learning, this only mirrored by those of her students who were deep learners such as Graham (A 9.12). Yet, properly constructed, differentiated tasks have the potential to develop deep learning, optimise self-regulatory learning strategies and allow students to accurately assess their self-efficacy of learning (A 9.12).

The learning approach of individual students varied considerably over the period of the research study. For Graham, Wade and Patricia the ability to operate at abstract relational level was not related to learning approach as much as innate ability in science. Moreover these students were able to select the most appropriate SRL strategies for the task at hand (A 9.12).

Contributions to Knowledge

This research has contributed to the body of existing knowledge and literature specifically in relation to an evaluation of a gifted and talented science program in the secondary school context in Western Australia. Literature is available regarding best practice pedagogy for gifted and talented students (Johnsen, Haensly, Ryser, & Ford, 2006; Macleod, 2005; Van Tassel-Baska & Stambaugh, 2006) and some literature for teachers of gifted secondary age students in science (S. Gallagher, 2006). Although it has been acknowledged that regular program evaluation is important to assess the impact of programs for the gifted (Van Tassel-Baska & Stambaugh, 2006), currently there is little evidence of such evaluation (Callahan, 2006; Taber, 2007a; Van Tassel-Baska, Quek, & Feng, 2007). Furthermore the limited research that does exist is mostly based on the primary school context which makes generalisations to the secondary context tenuous (Callahan, 2006). One contemporary study has reported the effects of implementing a program for gifted science students in a secondary school, but the research was based in Korea and focused specifically on the implementation of open-ended science practical investigations (Park & Oliver, 2009).

Limited literature is available on learning approach, self-regulatory learning and self-efficacy beliefs of gifted students (Patrick, Gentry, & Owen, 2006) and lacking in respect to how each of these intrapersonal characteristics are affected specifically as a consequence of participation in a gifted and talented science program in a secondary school context.

The goal of each and every classroom teacher is to maximise the learning of the individual students in their classes. Often the heterogeneous nature of a science class impacts on this goal as the teacher prioritises elements of the teaching and learning context and makes compromises. Within MHS, a special program, the GTSP, was devised to ensure that the needs of the students with the most potential in science would be met. A lot was expected by the students themselves, parents, teachers and administrators, although the nature of the expectations differed. Demonstrated evidence of achievement exists in student reports, but such evidence provides little data on which to evaluate the success of a special program. Furthermore, there is much reported evidence of gifted underachievement when students' outstanding natural abilities remain potentialities (Gagné, 2010; Hoover-Schultz, 2005; S.M. Reis & Morales-Taylor, 2010). This research was an attempt to evaluate the GTSP and the role the program played in the optimisation of the potential of gifted and talented science students in a secondary school setting. The research provided contextual information far beyond rankings of student achievement on which the success of many programs, schools and even education systems are currently based. There is limited evaluation data relating to specific teaching programs in the literature, furthermore it is hard to find published research based on longitudinal data collected by an experienced teacher with tacit knowledge in situ.

It is hoped that this multifaceted research has provided insights about how to further improve the GTSP to optimise the students' potential. The findings of this research are not solely confined to gifted and talented students per se. Where the findings can be transferred to science and mainstream classes in general then the research has bearing on the education of all secondary students (Renzulli, 2005; Taber, 2007a)

Limitations

The limitations inherent in this study may affect the generalisation of the research findings to other contexts. Teachers of the gifted, teachers of science and mainstream teachers from other disciplines should be mindful of the particular context of this study before attempting to apply the findings of this study to their own programs.

The Researcher has noted the following limitations of this study. Firstly since this was an evaluation of a specific program at one school for a particular year group as they progressed through Year 8 and Year 9 number of research participants is small. The consent rate of students in the first year of the study reduced the number of participants that could be tracked over the research period. Furthermore students moving in and out of the program reduced the amount of data collected over the full two year study.

The interview data are self-reports from students being interviewed by a teacher in researcher mode which may have affected the responses. There is no evidence to corroborate what students say they do in response to interview questions. Furthermore, the Researcher was inexperienced in interview techniques which require skill to ask open ended questions that probe a construct such as self-regulation without leading the interviewee, consequently the interviews conducted were rather limited in scope

The use of self-report surveys on the learning approach, self-efficacy and perceptions of the classroom of the students presents limitations as discussed in Chapter 3. Since students were completing the same survey on a number of occasions practice effects and boredom may have influenced the results. The available instruments for learning approach and classroom environment have inherent limitations. The LPQ and R-LPQ-2F present low Cronbach's alpha values on a number of subcomponents. Of particular note, having persisted in use of the LPQ as a research instrument to allow categorisation of a student's learning approach, was the difficulty of assigning a student a learning approach profiles against the reported data. This complicated both the selection of students for interview and the data analysis phase. The ICEQ and cICEQ showed differences in Cronbach's alpha values in various phases of the study. Inclusion of more sophisticated statistical tests such as ANOVA, multiple regression and canonical correlations, as appropriate, may have provided greater insights in relation to the quantitative data.

Although the Researcher was a classroom teacher, she was not experienced in classroom observation for the purpose of data collection for research purposes. The data from participant observation were collected in the form of field notes. Video footage of the classes would have extended the data collected and allowed the Researcher to view the lessons multiple times enhancing the rigour of data analysis.

Classroom Implications

The purpose of this research was to examine the factors that assisted students in the GTSP to achieve their academic potential. Accordingly, it is fitting that as a result of this study some implications for future teaching within the context of gifted and talented science education are discussed. The following sections address the implications of this research with respect to selection methods, learning approach, assessment, self-regulation, self-efficacy of learning and classroom environment.

Selection Methods

Where the HAST is used for selection of students into programs such as the GTSP this should be done on the basis of the overall HAST score, rather than relying predominantly on the mathematics component.

Learning Approach and Assessment Practices

Several factors appeared to be operating that will ultimately affect the sustained translation of an individual's gifts into talent over the long term. There was evidence of constructive misalignment within the GTSP. The administration and culture of MHS emphasised the results of common assessment tasks (CATs) which generally took the form of in-class tests. Ultimately, the type of strategies viewed as adaptive for the CATs were those aligned to a surface learning approach, such as memorisation. MHS should look to other available ranking data, such as that provided from the MSE Science Test rather than relying predominantly on data from common assessment tasks.

The GTSP students had limited opportunities to develop adaptive self-regulatory strategies by engaging in tasks of appropriate cognitive difficulty. Further emphasis needs to be placed on the development of a deep approach to learning by providing motivating tasks that require students to utilise those strategies aligned to deep learning. Metacognition will then take place with reference to the strategies employed for this type of task.

Whilst MHS has no control over test construction at state and national level, multiple choice questions should be used with caution on common assessment tasks as they promote surface learning which is not adaptive in the long term for achievement of one's full potential.

In general one would expect that students with a deep approach would be looking for ways to build their understanding, however, in situations where students experience success with surface approaches and minimal effort, it is unlikely that they will extend themselves. Until assessment tasks challenge the GTSP students they will continue to rely on those study strategies that have served them well in the past. Teachers need to continue to send the message that rewards come to those who strive for excellence so that an achieving motive is seen by students to be adaptive.

Self-Regulation

Teachers need to continue to promote the importance of self-regulatory learning strategies in situ. Maintenance of a safe classroom environment will facilitate SRL strategies such as help-seeking. The regular use of student surveys such as the rICEQ, provide a lens for the teacher to view the perceptions of the students relating to a safe classroom environment.

The following are recommendations based on the findings of this research for the improved autonomous use of cognitive organisers as a self-regulatory strategy, not only by the Year 9 gifted and talented science students at Metropolitan High School, but by students in general.

The autonomous use of specific cognitive organiser by a student appears to be influenced by a number of factors. The conceptual model shown in Figure 10.1 attempts to illustrate how each variable may operate sequentially to facilitate or hinder the development of autonomy in the use of organisers (Tan, Dawson, & Venville, 2008).

First, the student needs to be exposed to a particular organiser, for example, a fishbone, which usually occurs during a period of instruction. A student cannot use an organiser that they have no knowledge of and there was no evidence of any student developing their own organiser. Prior exposure to a specific organiser is, therefore, likely to be the first factor to impact on autonomous student use of a specific cognitive organiser and is included at the top of Figure 10.1.

Organisers vary in complexity. Some, like the structured overview, are merely a way of assisting transformation of data into note form. At their most simplistic, note making categories may be based on the chapter headings in the student's textbook. Such an organiser may be used with ease by a learner at the concrete multi-structural stage on the SOLO taxonomy (Collis & Biggs, 1979). A concept map is more complex, requiring the student to show the relationships between concepts. A student using a concept map would need to be at the concrete relational stage, or higher, if the concept involves a degree of abstraction. Thus, the complexity of the cognitive organiser needs to be matched to the student's stage on the SOLO taxonomy. However, students tend to rely on organisers that are less cognitively demanding. Thus, the students' level of cognitive processing is the second factor leading to autonomous use of cognitive organisers in Figure 10.1.

Unless a student has the opportunity to use an organiser a number of times, the organiser is unlikely to become embedded in their repertoire of personal strategies. Thus, use of the organiser will be limited to those times when the teacher prompts the student to use it. Including the use of organisers within the criteria for assessment tasks would also facilitate transfer as students would be forced to contemplate the use of a specific organiser for a particular purpose. Teachers need to be mindful of aligning an appropriate organiser with the task at hand. This implies a certain level of pedagogical content knowledge in the use of organisers by the teacher. Whether the organiser is embedded in the student's repertoire of strategies is included in Figure 10.1 as a third factor leading to autonomous use of specific cognitive organisers.

Teachers use their pedagogical content knowledge to match an appropriate strategy to a task. For autonomous use of a cognitive organiser, a student needs to emulate this skill. The results of this study demonstrated that students had difficulty matching an appropriate cognitive organiser with a specific task. When introducing a new organiser, a teacher can facilitate student understanding of its use by thinking aloud and discussing the merits of the organiser in the specific context. This will assist students to develop the conditional knowledge needed to select appropriate strategies. Reflection on the efficacy of an organiser to assist thinking, a metacognitive process, assists students in their autonomous choice of organiser for related tasks in the future.

The ability of the student to select an organiser with an appropriate structure for successful task completion is the fourth factor included in Figure 10.1.

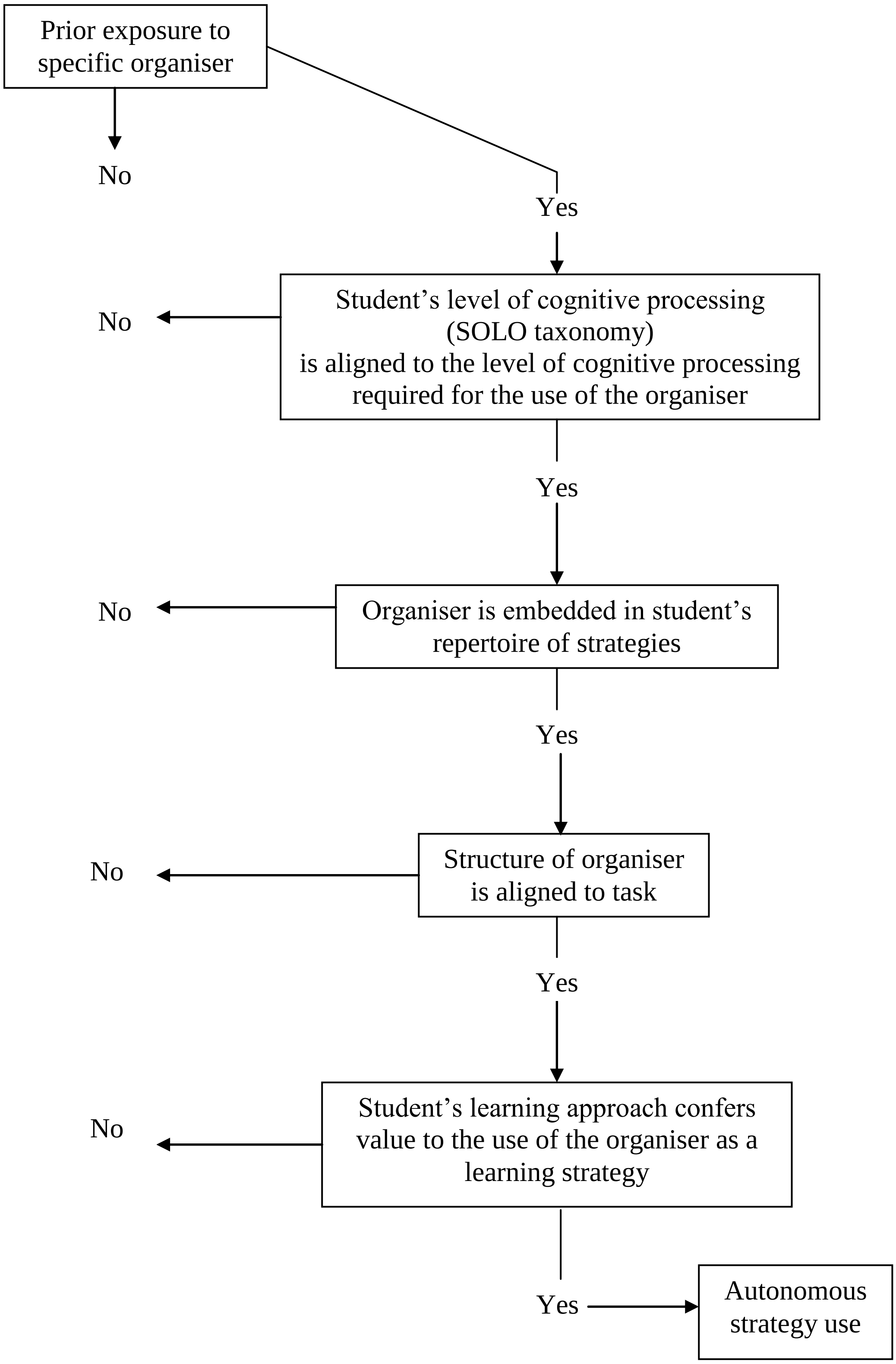

Figure 10.1. Factors leading to autonomous student use of a specific cognitive organiser.

Finally, it became evident in this research that the students needed a motive for using a particular organiser, unless the student sees value in its use, they will not use it. The deep learners in this research added to their conceptual frameworks each time they reviewed their work, but resisted representing their understanding in the form of a concept map for various reasons. They did not recognise the value in making links between concepts at least not on paper. As a consequence, the fifth factor leading to autonomous student use of cognitive organisers included in Figure 10.1 is that the students' learning approach confers value to the use of the organiser as a learning strategy.

Self-Efficacy

Whilst not wishing students to have reduced perceptions of personal self-efficacy of learning, the present educational context within the GTSP is providing the students with an overinflated estimation of their abilities. This is impacting on their metacognitive processes and their understanding of the need to develop more adaptive strategies for tasks presenting more cognitive challenge, but within their zone of proximal development. Gifted students would benefit from being exposed to differentiated tasks that encompass the limits of conceptual understanding of even the most able students so that each child can make a true evaluation of their ability to utilise appropriate strategy when cognitively challenged.

Classroom Environment

Those students with a surface or achieving approach were achieving success on CATs without the expenditure of a great deal of effort. The result was an impact on their perceptions of an ideal classroom, specifically a decline in preference for *Investigation, Independence* and *Differentiation.* In the literature (Macleod, 2005) it is these constructs which are advocated as essential for the development of an education program for the gifted and talented. Therefore teacher development of an ideal classroom environment takes into consideration environmental fit with their students' preferences and understanding of best practice pedagogy to meet their students' intellectual needs. Rather than attempting alignment of the actual learning environment to the preferred learning environment of their students by altering teaching methods regarded as best practice, education of the students regarding the value of such practice for gifted and talented students is advocated.

Implications of this Study for Future Research

Since it appears the lack of constructive alignment in the GTSP context has had implications on both learning approach and self-regulated learning, an evaluation of the effect of replacing at least half of the common assessment tasks with authentic tasks of higher cognitive challenge is needed. Research into the autonomous use of cognitive organisers by gifted and talented students following a whole school initiative would also be beneficial to determine if greater exposure to organisers translated into more autonomous use of organisers particularly for the successful completion of authentic tasks designed to challenge the whole range of students in a gifted and talented class. Since outcomes are influenced by the motivation to persevere and level of interest in science this area is worthy of further research. A study of the extent to which students in gifted and talented classes approach peers for assistance would be valuable, since this is one reason for grouping students into such classes.

A Final Reflection

Looking smart is not the ultimate goal. This study has drawn attention to the need for constructive alignment in gifted and talented science programs. Institutional climate can result in forces that derail the alignment of assessment practices to the philosophy underpinning gifted education. Whilst students are able to demonstrate high achievement and look smart, such a mismatch undermines the development of the skills of life-long learning namely deep motive and related self-regulatory learning strategy. Whilst students' levels of achievement and self-efficacy beliefs are not compromised at lower secondary level, assessment practices that fail to provide appropriate cognitive challenge will eventually curb the realisation of the gifted students' potential. Ultimately our society will benefit from the application of a student's gifts. It is within our schools and programs such as the GTSP that these gifts are nurtured and honed.

REFERENCES

Ablard, K. E., & Lipschultz, R. E. (1998). Self-regulated learning in high-achieving students: Relations to advanced reasoning, Achievement goals and gender. *Journal of Educational Psychology, 90*(1), 94-101.

Abrams, E. (1998). Talking and doing science: Important elements in a teaching-for-understanding approach. In J. Mintzes, J. Wandersee & J. Novak (Eds.), *Teaching science for understanding. A human constructivist view* (pp. 307-323). San Diego, California: Academic Press.

Aldridge, J. M., Fraser, B. J., & Fisher, D., L. (2003). *Investigating student outcomes in an outcomes-based, technology-rich learning environment.* Paper presented at the Third International Conference on Science, Mathematics and Technology Education, East London.

Ames, C. (1992a). Achievement goals and the classroom motivational climate. In D. H. Schunk & J. L. Meece (Eds.), *Student perceptions in the classroom* (pp. 327-348). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Ames, C. (1992b). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84*(3), 261-271.

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of educational psychology, 80*(3), 260-267.

Anders Ericsson, K., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data*. London: MIT Press.

Assor, A., & Conell, J. P. (1992). The validity of students' self-reports as measures of performance affecting self-appraisals. In D. H. Schunk & J. L. Meece (Eds.), *Student perceptions in the classroom* (pp. 25-47). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Baeten, M., Dochy, F., & Struyven, K. (2008). Students' approaches to learning and assessment preferences in a portfolio-based learning environment. *Instructional Science*(36), 359-374.

Bain, K., & Zimmerman, J. (2009). Understanding great teaching. *Peer Review, 11*(2), 9-13.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. NY: W.H. Freeman and Company.

Bellanca, J. (1992). *The cooperative think tank II: Graphic organizers to teach thinking in the cooperative classroom*. IL: IRI/Skylight Training and Publishing, Inc.

Bennett, B., & Rolheiser, C. (2006). *Beyond Monet: The artful science of instructional integration*. Toronto: Bookation Inc.

Biggs, J. (1987a). *Learning process questionnaire manual*. Hawthorn: Australian Council for Educational Research.

Biggs, J. (1987b). *Student approaches to learning and studying*. Melbourne: Australian Council for Educational Research.

Biggs, J. (1988). Approaches to learning and essay writing. In R. R. Schmeck (Ed.), *Learning strategies and learning styles* (pp. 185-228). NY: Plenum Press.

Biggs, J. (2002, 4th November 2002). *Aligning Curriculum to support good learning.* Paper presented at the Constructive Alignment in Action: Imaginative Curriculum Symposium, LTSN Generic Centre.

Biggs, J. (2003). *Teaching for quality learning at university* (2nd ed.). Maidenhead: Open University Press.

Biggs, J., & Moore, P. (1993). *The process of learning* (3rd ed.). Sydney: Prentice Hall.

Black, P., Harrison, C., Lee, C., Marshall, B., & Wiliam, D. (2002). *Working inside the black box*. London: nferNelson Publishing Company Ltd.

Boekaerts, M. (1996). Self-regulated learning at the junction of cognition and motivation. *European Psychologist, 1*(2), 100-112.

Boekaerts, M., & Cascallar. (2006). How far have we moved towards integration of theory and practice in self-regulation. *Educational Psychology Review, 18*, 199-210.

Boulton-Lewis, G. (1998). Applying the SOLO taxonomy to learning in higher education. In B. Dart & G. Boulton-Lewis (Eds.), *Teaching and learning in higher education* (pp. 201-221). Melbourne: The Australian Council for Educational Research Ltd.

Bouma, G. D., & Ling, R. (2004). *The research process* (5th ed.). Melbourne: Oxford University Press.

Brophy, J. (1999). Research on motivation in education: Past, present, and future. In T. C. Urdan (Ed.), *Advances in motivation and achievement: The role of context* (Vol. 11, pp. 1-44). Stamford, CT: Jai Press Inc.

Brophy, J., & Alleman, J. (1992). Planning and managing learning activities: Basic principles. In J. Brophy (Ed.), *Advances in research on teaching: Planning and managing learning tasks and activities* (Vol. 3, pp. 1-46). Greenwich, CT: Jai Press Inc.

Burke Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research, 1*(2), 112-133.

Bybee, R. W. (1993). *Reforming science education: Social perspectives and personal reflections.* NY: Teachers College Press.

Callahan, C. (2006). Secondary program models and the evaluation of secondary programs. In F. A. Dixon & S. M. Moon (Eds.), *The handbook of secondary gifted education* (pp. 505-523). Waco, TX: Prufrock Press Inc.

Cassidy, S. (2006). Learning style and student self-assessment skill. *Education & Training, 48*(2/3), 170-177.

Cekolin, C. H. (2001). *The effect of self-regulated learning instruction on strategy use and academic achievement.* Unpublished PhD, South Alabama University, South Alabama.

Chaffey, G. (2005). Understanding underachievement in gifted students. In *Gifted and talented education: Professional development package for teachers: Module 4*. Sydney: UNSW.

Coakes, S. J. (2005). *SPSS version 12.0 for windows: Analysis without anguish.*: John Wiley and Sons Australia Ltd.

Cobern, W. W. (1993). Contextual constructivism: The impact of culture on the learning and teaching of science. In K. Tobin (Ed.), *The practice of constructivism in science education* (pp. 51-70). Hove: Lawrence Erlbaum Associates.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). London, UK: Routledge Falmer.

Collis, K., & Biggs, J. (1979). *Classroom examples of cognitive development phenomena: The SOLO taxonomy*. Tasmania: University of Tasmania.

Coutinho, S., & Neuman, G. (2008). A model of metacognition, achievement goal orientation, learning style and self-efficacy. *Learning Environment Research, 11*, 131-151.

Cowan, I. J. (2002). *Multiple goal orientation and metacognition in middle school students.* Unpublished Master of Arts in School Psychology, Mount Saint Vincent, Mount Saint Vincent, Canada.

Cresswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research*. London: SAGE Publications Inc.

Curriculum Council. (1998). *Curriculum framework for kindergarten to year 12 education in Western Australia*. Perth: Curriculum Council of WA.

Department of Education and Training. (2005). *Outcomes and standards framework: Science*. Perth: Department of Education and Training.

Dinsmore, D., Alexander, P., & Loughlin, S. (2008). Focusing the conceptual lens on metacognition, self-regulation and self-regulated learning. *Educational Psychology Review, 20*, 391-409.

Dorman, J. (2002). Classroom environment research: Progress and possibilities. *Queensland Journal of Educational Research, 18*(2), 112-140.

Duarte, A. (2007). Conceptions of learning and approaches to learning in Portuguese students. *Higher Education, 54*, 781-794.

Duit, R., & Confrey, J. (1996). Reorganizing the curriculum and teaching to improve learning in science and mathematics. In D. F. Treagust, R. Duit & B. J. Fraser (Eds.), *Improving teaching and learning in science and mathematics* (pp. 79-93). London: Teachers College Press.

Dweck, C. S. (1985). Intrinsic motivation, perceived control, and self-evaluation maintenance: An achievement goal analysis. In C. Ames & R. E. Ames (Eds.), *Research on motivation in education: The classroom milieu* (Vol. 2, pp. 289-303). Orlando, FL: Academic Press, Inc.

Education Department of Western Australia. (1998). *Outcomes and standards framework: Student outcome statements: Overview*. West Australia: Author.

Entwistle, N. (1988). Motivational factors in students' approaches to learning. In R. R. Schmeck (Ed.), *Learning strategies and learning styles* (pp. 21-52). NY: Plenum Press.

Feden, P. D., & Vogel, R. M. (2003). *Methods of teaching: Applying cognitive science to promote student learning*. Sydney: McGraw-Hill.

Frangenheim, F. (2002). *Reflections on classroom thinking strategies* (4th ed.). Loganholme: Rodin Educational Publishing.

Fraser, B. J. (1990). *Individualised classroom environment questionnaire*. Hawthorn: The Australian Council for Educational Research Ltd.

Fraser, B. J. (1994). Research on classroom and school climate. In D. L. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 493-541). Sydney: Macmillan Publishing Company.

Fraser, B. J., & Lee, S. (2009). Science laboratory classroom environments in Korean high schools. *Learning Environments Research, 12*, 67-84.

Gagné, F. (2006). *The developmental model of giftedness and talent.* Paper presented at the Gagne Conference: Gifted and Talented Education, Perth, Western Australia.

Gagné, F. (2010). Motivation within the DMGT 2.0 framework. *High Ability Studies, 21*(2), 81-99.

Gallagher, J. (1993). Secondary science teachers and constructivist practice. In K. Tobin (Ed.), *The practice of constructivism in science education* (pp. 181-192). Hove: Lawrence Erlbaum Associates.

Gallagher, S. (2006). Guiding gifted students towards science expertise. In F. Dixon, A & S. M. Moon (Eds.), *The handbook of secondary gifted education* (pp. 427-460). Waco, TX: Prufrock Press Inc.

Gijbels, D., Sergers, M., & Struyf, E. (2008). Constructivist learning environments and the (im)possibility to change students' perceptions of assessment demands and approaches to learning. *Instructional Science, 36*, 431-443.

Goodrum, D. (2004). Teaching strategies for science classrooms. In G. Venville & V. Dawson (Eds.), *The art of teaching science* (pp. 54-72). Crows Nest, NSW: Allen & Unwin.

Graziano, A., & Raulin, M. (2004). *Research methods: A process of inquiry* (5th ed.). Sydney: Pearson Education Group, Inc.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis, 11*, 255-274.

Gross, M. U. M. (1993). *Exceptionally gifted children*. London: Routledge.

Gross, M. U. M. (2005a). Social and emotional development of gifted students. In *Gifted and talented education: Professional development package for teachers: Module 3*. Sydney: UNSW.

Gross, M. U. M. (2005b). Understanding giftedness. In *Gifted and talented education: Professional development package for teachers: Module 1*. Sydney: UNSW.

Gunstone, R. F. (1995). Constructivist learning and the teaching of science. In B. Hand & V. Prain (Eds.), *Teaching and learning in science: The constructivist classroom* (pp. 3-20). Sydney: Harcourt Brace & Company, Australia.

Hackling, M. (2003). *Levels of learning outcomes that span the primary and lower secondary years for the conceptual strands in the science learning area*. Perth, Western Australia: Edith Cowan University.

Harackiewicz, J. M., Pintrich, P. R., Elliot, A. J., & Thrash, T. M. (2002). Revision of achievement goal theory: Necessary and illuminating. *Journal of Educational Psychology, 94*(3), 638-645.

Hart, D. (1994). *Authentic assessment: A handbook for educators*. MA: Addison-Wesley.

Hattie, J., & Purdie, N. (1998). The SOLO model: Addressing fundamental measurement issues. In B. Dart & G. Boulton-Lewis (Eds.), *Teaching and learning in higher education*. Melbourne: The Australian Council for Educational Research Ltd.

Hertzog, N. B. (2004). Open-ended activities: Differentiation through learner responses. In C. A. Tomlinson (Ed.), *Differentiation for gifted and talented students* (pp. 77-104). Heatherton: Hawker Brownlow Education.

Hong, E., & Aqui, Y. (2004). Cognitive and motivational characteristics of adolescents gifted in mathematics: Comparisons amongst students with different types of giftedness. *The Gifted Child Quarterly, 48*(3), 191-202.

Hoover-Schultz, B. (2005). Gifted underachievement: oxymoron or educational enigma? *Gifted Child Today, 28*(2), 46-52.

Jagacinski, C. M. (1992). The effects of task involvement and ego involvement on achievement-related cognitions and behaviours. In D. H. Schunk & J. L. Meece (Eds.), *Student perceptions in the classroom* (pp. 307-326). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Janesick, V. J. (2000). The choreography of qualitative research design. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 379-400). London: SAGE Publications, Inc.

Jinks, J., & Morgan, V. (1999). Children's perceived academic self-efficacy: An inventory scale. *The Clearing House, 72*(4), 224-231.

Johnsen, S. K., Haensly, P. A., Ryser, G. R., & Ford, R. F. (2006). Changing general education classroom practices to adapt for gifted students. In S. M. Reis (Ed.), *Differentiation for gifted and talented students* (pp. 133-164). Heatherton: Hawker Brownlow.

Kember, D., Biggs, J., & Leung, D. (2004). Examining the multidimensionality of approaches to learning through the development of a revised version of the Learning Process Questionnaire. *British Journal of Educational Psychology, 74*(2), 261-280.

Kember, D., & Leung, D. (1998). The dimensionality of approaches to learning: An investigation with confirmatory factor analysis of the structure of the SPQ and LPQ. *British Journal of Educational Psychology, 68*(3), 395-408.

Kember, D., Wong, A., & Leung, D. (1999). Reconsidering the dimensions of approaches to learning. *British Journal of Educational Psychology, 69*(3), 323-344.

Kitzinger, J., & Barbour, R. S. (1999). Introduction: The challenge and promise of focus groups. In J. Kitzinger & R. S. Barbour (Eds.), *Developing focus group research: Politics, theory and practice* (pp. 1-20). London: SAGE Publications.

Kumar, R. (1999). *Research methodology: A step by step guide for beginners*. London: Sage Publications Ltd.

Lochhead, J. (2001). *Thinkback: A user's guide to minding the mind*. London: Lawrence Erlbaum Associates.

Loughran, J., Berry, A., & Mulhall, P. (2007). Pedagogical content knowledge: What does it mean to science teachers? In R. Pinto & D. Cousa (Eds.), *Contributions from science education research* (pp. 93-105). Dordrecht: Springer.

Macleod, B. (2005). Curriculum differentiation for gifted and talented students. In *Gifted and talented education: Professional development package for teachers: Module 5*. Sydney: UNSW.

Maehr, M. L., & McInerney, D. M. (2004). Motivation as personal investment. In D. M. McInerney & S. Van Etten (Eds.), *Big theories revisited* (Vol. 4, pp. 61- 90). Greenwich, Connecticut: Information Age Publishing.

Mansfield, C. (2001). *Contextual influences on student motivation in the first year of middle school.* Paper presented at the Annual Conference of the Australian Association for Research in Education, Fremantle, Western Australia.

Martens, L. R. (2004). *The development of student metacognition and self-regulated learning in the classroom by monitoring learning strategies and response-certitude on assessments.* Unpublished PhD, Emporia State University, Kansas.

Marton, F. (1988). Describing and improving learning. In R. R. Schmeck (Ed.), *Learning strategies and learning styles* (pp. 53-82). NY: Plenum Press.

McCoach, D., & Siegle, D. (2003). The structure and function of academic self-concept in gifted and general education students. *Roeper Review, 25*(2), 61-66.

McInerney, D. M., & McInerney, V. (1998). *Educational Psychology: Constructing learning* (2nd ed.). Sydney: Prentice Hall.

Meece, J. L. (1991). The classroom context and students' motivational goals. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement* (Vol. 7, pp. 261-286). Greenwich, CT: Jai Press Inc.

Meece, J. L., Blumenfeld, P. C., & Hoyle, R. H. (1988). Students' goal orientations and cognitive engagement in classroom activities. *Journal of Educational Psychology, 80*(4), 514-523.

Mellanby, J., Cortina-Borja, M., & Stein, J. (2009). Deep learning questions can help selection of high ability candidates for universities. *Higher Education, 57*, 597-608.

Melograno, V. J. (1996). Portfolio assessment: Documenting authentic student learning. In R. Fogarty (Ed.), *Student portfolios: A collection of articles* (pp. 165-182). Australia: Hawker Brownlow Education.

Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass Publishers.

Mertens, D. M. (2005). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative and mixed methods* (2nd ed.). London: SAGE Publications.

Meyer, J. H. F. (1998). A medley of individual differences. In B. Dart & G. Boulton-Lewis (Eds.), *Teaching and learning in higher education* (pp. 42-71). Melbourne: The Australian Council for Educational Research Ltd.

Midgley, C., Kaplan, A., & Middleton, M. (2001). Performance-approach goals: Good for what, for whom, under what circumstances and at what cost? *Journal of Educational Psychology, 93*(1), 77-86.

Miller, S., Heafner, T., & Massey, D. (2009). High-School Teachers' Attempts to Promote Self-Regulated Learning: "I may learn from you, yet how do I do it?" *The Urban Review, 41*, 121-140.

Moore, N. (2000). *How to do research: A complete guide to designing and managing research projects* (3rd ed.). London: Library Association Publishing.

Newman, R. S., & Schwager, M. T. (1992). Student perceptions and academic help seeking. In D. H. Schunk & J. L. Meece (Eds.), *Student perceptions in the classroom* (pp. 123-146). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Nicholls, J. G. (1984). Conceptions of ability and achievement motivation. In R. E. Ames & C. Ames (Eds.), *Research on motivation in education: Student motivation* (Vol. 1, pp. 39-68). Orlando, FL: Academic Press, Inc.

Novak, J. (1996). Concept mapping: A tool for improving science teaching and learning. In D. F. Treagust, R. Duit & B. J. Fraser (Eds.), *Improving teaching and learning in science and mathematics* (pp. 32-43). London: Teachers College Press.

Pajares, F. (1996). Self efficacy beliefs in academic settings. *Review of Educational Research, 66*(4), 543-579.

Pajares, F. (2002). Gender and perceived self-efficacy in self-regulated learning. *Theory into Practice, 41*(2), 116-128.

Paris, S. G., & Byrnes, J. P. (1989). The constructivist approach to self regulation and learning in the classroom. In B. J. Zimmerman & D. H. Schunk (Eds.), *Self-regulated learning and academic achievement theory research and practice: Progress in developmental research* (pp. 169-200). NY: Springer-Verlag New York Inc.

Paris, S. G., & Paris, A. H. (2001). Classroom applications of research on self-regulated learning. *Educational Psychologist*, *36*(2), 89-101.

Park, S., & Oliver, J. (2009). The translation of teacher's understanding of gifted students into instructional strategies for teaching science. *Journal of Science Teacher Education 20*, 333-351.

Parks, S., & Black, H. (1992). *Organising thinking: Graphic organisers*. Cheltenham: Hawker Brownlow Education.

Pask, G. (1988). Learning strategies, teaching strategies, and conceptual or learning style. In R. R. Schmeck (Ed.), *Learning strategies and learning styles* (pp. 83-100). NY: Plenum Press.

Patrick, H., Gentry, M., & Owen, S., V. (2006). Motivation and gifted adolescents. In F. A. Dixon & S. M. Moon (Eds.), *The handbook of secondary gifted education* (pp. 165-195). Waco, TX: Prufrock, Press Inc.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. London: Sage Publications.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). London: Sage Publications, Inc.

Pintrich, P. R. (2000). Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. *Journal of Educational Psychology, 92*(3), 544-555.

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *82*(1), 33-40.

Pintrich, P. R., & Garcia, T. (1991). Student goal orientations and self-regulation in the college classroom. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement* (Vol. 7, pp. 371-402). Greenwich, CT: Jai Press Inc.

Pintrich, P. R., & Schrauben, B. (1992). Students' motivational beliefs and their cognitive engagement in classroom academic tasks. In D. H. Schunk & J. L. Meece (Eds.), *Student perceptions in the classroom* (pp. 149-183). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Plowman, P. D. (1980). Programming for the gifted child. In J. S. Renzulli & E. P. Stoddard (Eds.), *Under One Cover: Gifted and Talented Education in Perspective* (pp. 220). Reston, VA: The Council for Exceptional Children.

Prain, V., & Hand, B. (1995). Introduction. In V. Prain & B. Hand (Eds.), *Teaching and learning science: The constructivist classroom* (pp. ix-xv). Sydney: Harcourt Brace and Company, Australia.

Pritchard, A. (2005). *Ways of learning: Learning theories and learning styles in the classroom*. London: David Fulton Publishers Ltd.

Prosser, M., & Trigwell, K. (1999). *Understanding learning and teaching: The experience in higher education*. Buckingham: Open University Press.

Purdie, N., Hattie, J., & Douglas, G. (1996). Student conceptions of learning and their use of self regulated learning strategies. *Journal of Educational Psychology, 88*(1), 87-100.

Raffini, J. P. (1993). *Winners without losers: Structures and strategies for increasing student motivation to learn*. Needham Heights, MA: Allyn and Bacon.

Ramsden, P. (2003). *Learning to teach in higher education* (2nd ed.). NY: Routledge Falmer.

Rayneri, L., Gerber, B., & Wiley, L. (2006). The Relationship between classroom environment and the learning style preferences of gifted middle school students and the impact on levels of performance. *The Gifted Child Quarterly, 50*(2), 104-121.

Reis, S. M. (2004). Self-regulated learning and academically talented students. *Parenting for high potential*, 5-12.

Reis, S. M., & Morales-Taylor, M. (2010). From high potential to gifted performance. Encouraging academically talented urban students. *Gifted Child Today, 33*, 28-38.

Rennie, L. J., Goodrum, D., & Hackling, M. (2001). Science teaching and learning in Australian schools: Results of a national study. *Research in Science Education, 31*, 455-498.

Renzulli, J. S. (2005). Applying gifted education pedagogy to total talent development for all students. *Theory into Practice, 44*(2), 80-89.

Richardson, J. T. E. (2000). *Researching student learning: Approaches to studying in campus based and distance education*. Buckingham: Open University Press.

Robinson, A., & Britton Kolloff, P. (2006). Preparing teachers to work with high-ability youth at the secondary level: Issues and implications for licensure. In F. A. Dixon & S. M. Moon (Eds.), *The handbook of secondary gifted education* (pp. 581-610). Waco, TX: Prufrock Press, Inc.

Roth, W. M. (1999). Authentic school science: Intellectual traditions. In R. McCormick & C. Paechter (Eds.), *Learning and knowledge* (pp. 6-20). London: SAGE Publications Ltd.

Rueda, R., & Dembo, M. H. (1995). Motivational processes in learning: A comparative analysis of cognitive and sociocultural frameworks. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement: Culture, motivation and achievement.* (Vol. 9, pp. 255-289). Greenwich, CT: Jai Press Inc.

Russell, T. (1993). Learning to teach science: Constructivism, reflection and learning from experience. In K. Tobin (Ed.), *The practice of constructivism in science education* (pp. 247-258). Hove: Lawrence Erlbaum Associates.

Ryan, A. M., & Patrick, H. (2001). The classroom social environment and changes in adolescents' motivation and engagement during middle school. *American Education Research Journal, 38*(2), 437-448.

Schmeck, R. R. (1988). An introduction to strategies and styles of learning. In R. R. Schmeck (Ed.), *Learning strategies and learning styles* (pp. 3-19). NY: Plenum Press.

Schraw, G., Crippen, K., & Hartley, K. (2006). Promoting self-regulation in science education: metacognition as part of a broader perspective on learning. *Research in Science Education, 36*, 111-139.

Schunk, D. H. (1989). Social cognitive theory and self-regulated learning. In B. J. Zimmerman & D. H. Schunk (Eds.), *Self-regulated learning and academic achievement: theory, research and practice* (pp. 83-110). NY: Springer- Verlag.

Schunk, D. H. (1991). Goal setting and self-evaluation: A social cognitive perspective on self-regulation. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement* (Vol. 7, pp. 85-113). Greenwich, CT: Jai Press Inc.

Schunk, D. H. (2008). Metacognition, self-regulation, and self-regulated learning: research recommendations. *Educational Psychology Review, 20*, 463-467.

Schunk, D. H., & Pajares, F. (2004). Self-efficacy in education revisited: Empirical and applied evidence. In D. M. McInerney & S. Van Etten (Eds.), *Research on sociocultural influences on motivation and learning: Big theories revisited* (Vol. 4, pp. 115-138). Greenwich, CT: Information Age Publishing.

Scott, P. (2007). Challenging gifted learners through classroom dialogue. In K. Taber (Ed.), *Science education for gifted learners* (pp. 100-111). NY: Routledge.

Sekowski, A., Siekanska, M., & Klinkosz, W. (2009). On individual differences in giftedness. In L. Shavinina (Ed.), *International handbook on giftedness* (pp. 466-486). Gatineau: Springer.

Shi, K., Wang, P., Wang, W., Zuo, Y., & Liu, D. (2001). Goals and motivation of Chinese students - testing the adaptive learning model. In F. Salili, C. Chiu & Y. Hong (Eds.), *Student motivation: The culture and context of learning* (pp. 249-272). NY: Kluwer Academic/Plenum Publishers.

Smee, R. (2005). Inside out: Transforming the education of gifted students in the middle years. *Australian Journal of Middle Schooling, 5*(2), 18-24.

Stake, R., E. (2000). Case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 435-454). London: Sage Publications, Inc.

Stewart, D. W., & Shamdasani, P. N. (1990). *Focus groups: Theory and practice* (Vol. 20). Newbury Park: SAGE Publications, Inc.

Stipek, D. J. (1993). *Motivation to learn: From theory to practice* (2nd ed.). Needham Heights, MA: Allyn and Bacon.

Taber, K. (2007a). An agenda for science education for gifted learners. In K. Taber (Ed.), *Science education for gifted learners* (pp. 212-216). NY: Routledge.

Taber, K. (2007b). Science education for gifted learners? In K. Taber (Ed.), *Science education for gifted learners* (pp. 1-14). NY: Routledge.

Taber, K., & Corrie, V. (2007). Developing the thinking of gifted students through science. In K. Taber (Ed.), *Science education for gifted learners* (pp. 71-84). NY: Routledge.

Taber, K., & Riga, F. (2007). Working together to provide enrichment for able science learners. In K. Taber (Ed.), *Science education for gifted learners* (pp. 182-196). NY: Routledge.

Tan, K., Dawson, V., & Venville, G. (2008). Use of cognitive organisers as a self-regulated learning strategy. *Issues in Educational Research, 18*(2).

Tashakkori, A., & Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches*. London: SAGE Publications.

Tomlinson, C. A. (2005). Quality curriculum and instruction for highly able students. *Theory into Practice, 44*(2), 160-166.

Treagust, D. F., & Chittleborough, G. (2001). Chemistry: A matter of understanding representations. In J. Brophy (Ed.), *Advances in research on teaching: Subject-specific instructional methods and activities* (Vol. 8, pp. 239-267). Oxford: Elsevier Science Ltd.

Turner, J. C., & Meyer, D. K. (1999). Integrating classroom context into motivation theory and research. In T. C. Urdan (Ed.), *The role of context* (Vol. 11, pp. 87-122). Stamford, CT: Jai Press Inc.

Urdan, T. C., Kneisel, L., & Mason, V. (1999). Interpreting messages about motivation in the classroom: Examining the effects of achievement goal structures. In T. C. Urdan (Ed.), *The role of context* (Vol. 11, pp. 123-158). Stamford, CN: Jai Press Inc.

Van Tassel-Baska, J. (2005). Gifted programs and services: What are the nonnegotiables? *Theory into Practice*, *44*(2), 90-97.

Van Tassel-Baska, J., Quek, C., & Feng, A. (2007). The development and use of a structured teacher observation scale to assess differentiated best practice. *Roeper Review*, *29*(2), 84-92.

Van Tassel-Baska, J., & Stambaugh, T. (2006). *Comprehensive curriculum for gifted learners* (3rd ed.). Sydney: Pearson Education, Inc.

Vance, K., & Miller, K. (1995). Setting up as a constructivist teacher: Examples from a middle secondary ecology unit. In B. Hand & V. Prain (Eds.), *Teaching and learning in Science: The constructivist classroom* (pp. 85-105). London: Harcourt Brace & Company.

Venville, G., & Dawson, V. (2004). *The art of teaching science*. Crows Nest, NSW: Allen & Unwin.

Vialle, W., Lysaght, P., & Verenikina, I. (2005). *Psychology for educators*. Southbank, Victoria: Thompson Social Science Press.

Vrugt, A., & Oort, F. (2008). Metacognition, achievement goals, study strategies and academic achievement: pathways to achievement. *Metacognition Learning, 30*, 123-146.

Wandersee, J. H. (2001). High school biology instruction: Targeting deeper understanding for biological literacy. In J. Brophy (Ed.), *Advances in research on teaching: Subject-specific instructional methods and activities* (Vol. 8, pp. 187-214). Oxford: Elsevier Science Ltd.

Watkins, D. (1998). Assessing approaches to learning: A cross-cultural perspective. In B. Dart & G. Boulton-Lewis (Eds.), *Teaching and learning in higher education* (pp. 124-144). Melbourne: The Australian Council for Educational Research Ltd.

Watters, D. J., & Watters, J. J. (2007). Approaches to Learning by Students in the Biological Sciences: Implications for Teaching. *International Journal of Science Education, 29*(1), 19-43.

Watts, M., & Pedrosa de Jesus, H. (2007). Asking questions in classroom science. In K. Taber (Ed.), *Science education for gifted learners* (pp. 112-127). NY: Routledge.

West, A. (2007). Practical work for the gifted. In K. Taber (Ed.), *Science education for gifted learners* (pp. 172-181). NY: Routledge.

White, R. T. (1988). *Learning science*. Oxford: Basil Blackwell Ltd.

Wilding, J., & Andrews, B. (2006). Life goals, approaches to study and performance in an undergraduate cohort. *British Journal of Educational Psychology, 76*, 171-182.

Wisker, G. (2001). *The postgraduate research handbook*. New York: Palgave Publishers Ltd.

Yin, R. K. (1994). *Case study research: Design and methods* (2nd ed.). London: SAGE Publications.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). London: Sage Publications Ltd.

Yoon, C. (2009). Self-regulated learning in instructional factors in the scientific inquiry of scientifically gifted Korean middle school students. *The Gifted Child Quarterly, 53*(3), 203-217.

Zimmerman, B. J. (1989a). Models of self-regulated learning and academic achievement. In B. J. Zimmerman & D. H. Schunk (Eds.), *Self-regulated learning and academic achievement theory, research and practice: Progress in cognitive development research* (pp. 1-26). NY: Springer-Verlag New York Inc.

Zimmerman, B. J. (1989b). A social cognitive view of self regulated academic learning. *Journal of Educational Psychology, 81*(3), 329-339.

Zimmerman, B. J. (2004). Sociocultural influence and students' development of academic self-regulation: A social-cognitive perspective. In D. M. McInerney & S. Van Etten (Eds.), *Research on sociocultural influences on motivation and learning: Big theories revisited* (Vol. 4, pp. 139-164). Greenwich, CT.

Zimmerman, B. J., Bonner, S., & Kovach, R. (1996). *Developing self-regulated learners: Beyond achievement to self-efficacy*. WA: American Psychological Association.

Zimmerman, B. J., & Martinez-Pons, M. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of Educational Psychology, 80*(3), 284-290.

Zimmerman, B. J., & Martinez-Pons, M. (1990). Student differences in self regulated learning: Relating grade, sex, and giftedness to self-efficacy and strategy use. *Journal of Educational Psychology*, *82*(1), 51-59.

Zimmerman, B. J., & Martinez-Pons, M. (1992). Perceptions of efficacy and strategy use in the self-regulation of learning. In D. H. Schunk & J. L. Meece (Eds.), *Student perceptions in the classroom* (pp. 185-207). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

APPENDICES

Appendix A

LPQ Questionnaire

1 I chose my present subjects mainly because of career prospects when I leave school, not because I'm particularly interested in them.

2 I find that at times my school work can give me a feeling of deep personal satisfaction.

3 I try to obtain high marks in all my subjects because of the advantage this gives me in competing with others when I leave school.

4 I tend to study only what's set; I usually don't do anything extra.

5 While I am studying, I often try to think of how useful the material that I am learning would be in real-life.

6 I regularly take notes from suggested readings and put them with my class notes on a topic.

7 I am put off by a poor mark on a test and worry about how I will do on the next test.

8 While I realise that others sometimes know better than I do, I feel I have to say what I think is right.

9 I have a strong desire to do best in all of my studies.

10 I find that the only way to learn many subjects is to memorise them by heart.

11 In reading new material, I am often reminded of material I already know and see the latter in a new light.

12 I try to work solidly throughout the term and revise regularly when the examinations are close.

13 Whether I like it or not, I can see that studying is for me a good way to get a well-paid or secure job.

14 I find that many subjects can become very interesting once you get into them.

15 I like the results of tests to be put up publicly so I can see by how much I beat some others in the class.

16 I prefer subjects in which I have to learn just facts to ones which require a lot of reading and understanding of material.

17 I find that I have to do enough work on a topic so that I can form my own point of view before I am satisfied.

18 I always try to do all of my assignments as soon as they are given to me.

19 Even when I have studied hard for a test, I worry that I may not be able to do well on it.

20 I find that studying some topics can be really exciting.

21 I would rather be highly successful in school even though this might make me unpopular with some of my class mates.

22 In most subjects I try to work things so that I do only enough to make sure I pass, and no more.

23 I try to relate what I have learned in one subject to what I already know in other subjects.

24 Soon after a class or lab, I re-read my notes to make sure I can read them and understand them.

25 I think that teachers shouldn't expect secondary school students to work on topics that are outside the set course.

26 I feel that I might one day be able to change things in the world that I see now to be wrong.

27 I will work for top marks in a subject whether or not I like the subject.

28 I find it better to learn just the facts and details about a topic rather than try to under stand all about it.

29 I find most new topics interesting and often spend extra time trying to find out more about them.

30 When a test is returned, I go over it carefully correcting all errors and trying to under stand why I made the original mistakes.

31 I will continue my studies only for as long as necessary to get a good job.

32 My main aim in life is to find out what to believe in and then to act accordingly.

33 I see doing well in school as a sort of game, and I play to win.

34 I don't spend time on learning things that I know won't be asked in the examinations.

35 I spend a great deal of my free time finding out more about interesting topics which have been discussed in different classes.

36 I usually try to read all the references and things my teacher says we should.

Appendix A

Learning Process Questionnaire Answer Sheet

Name____

Date_________________________ Year level______________

Age ____________ ___________
Years Months

NB Question numbers go across the page in groups of six

Shade the box that corresponds to your response for each question

Key to Responses

5 means . . . **Always** or **almost always** true of me

4 means . . . **Frequently** true of me

3 means . . . True of me about **half the time**

2 means . . . **Sometimes** true of me

1 means . . . **Never** or **only rarely** true of me

Q	Response					Q	Response					Q	Response					Q	Response					Q	Response					Q	Response				
	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5
1						2						3						4						5						6					
7						8						9						10						11						12					
13						14						15						16						17						18					
19						20						21						22						23						24					
25						26						27						28						29						30					
31						32						33						34						35						36					
SM						DM						AM						SS						DS						AS					

Appendix B

Reliability Data for the LPQ Scale Score

		Test-retest		Internal consistency (alpha coefficients)	
		LPQ Year 11		LPQ	
		a	b	Age 14	Year 11
Surface	M	0.60	0.70	0.46	0.45
	S	0.49	0.60	0.51	0.55
	A	NA	NA	0.60	0.60
Deep	M	0.63	0.60	0.56	0.54
	S	0.52	0.63	0.67	0.65
	A	NA	NA	0.76	0.73
Achieving	M	0.70	0.67	0.68	0.67
	S	0.72	0.68	0.67	0.73
	A	NA	NA	0.77	0.78

a from Cornell (1986) cited in Biggs 1987, p. 23 (n=60; four months between testing)

b from Edwards (1986) cited in Biggs 1987, p. 23 (n=69; four months between testing)

(Biggs, 1987a, p. 23).

Appendix C

cLPQ Questionnaire

1 Whether I like it or not, I can see that doing well in school is a good way to get a well paid job.
2 I find that at times studying makes me feel happy and satisfied.
3 I try to obtain high marks in all my subjects because of the advantage this gives me in competing with others when I leave school.
4 I generally restrict my study to what is specifically set as I think it is unnecessary do anything extra.
5 I like constructing theories to fit odd things together.
6 I regularly take notes from suggested readings and put them with my class notes on a topic.
7 I am discouraged by a poor mark on a test and worry about how I will do on the next test.
8 I come to most classes with questions in mind that I want answered.
9 I have a strong desire to do best in all of my studies.
10 I learn some things by rote, going over and over them until I know them by heart even if I do not understand them.
11 I try to relate new material, as I am reading it, to what I already know on that topic.
12 I try to work solidly throughout the term and revise regularly when the examinations are close.
13 I intend to study to year 12 or beyond because I feel that I will then be able to get a better job.
14 I feel that nearly any topic can be highly interesting once you get into it.
15 I like the results of tests to be put up publicly so I can see by how much I beat some others in the class.
16 I find the best way to pass tests is to remember answers to likely questions.
17 I like to do enough work on a topic so that I can form my own conclusions before I am satisfied.
18 I always try to do all of my assignments as soon as they are given to me.
19 Even when I have studied hard for a test, I worry that I may not be able to do well in it.
20 I work hard at my studies because I find the material interesting.
21 I would rather be highly successful in school even though this might make me unpopular with some of my class mates.
22 As long as I feel I am doing enough to pass tests, I devote as little time to studying as I can. There are many more interesting things to do.
23 I try to relate what I have learned in one subject to what I learn in other subjects.
24 Soon after a class or lab, I re-read my notes to make sure I can read them and understand them.
25 I find that it is not helpful to study topics in depth. You really don’t need to know that much in order to get by in most topics.
26 I will work for top marks in a subject whether or not I like the subject.
27 I find I can get by in most common assessments by memorising key sections rather than trying to understand them.
28 When I read a textbook, I try to understand what the author means.
29 When a test is returned, I go over it carefully correcting all errors and trying to under stand why I made the original mistakes.
30 I find that I am continually going over my school work in my mind at times like when I am on the bus, walking, or lying in bed, and so on.
31 I see doing well in school as a sort of game, and I play to win.
32 I see no point in learning material which is not likely to be in the test.
33 I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.
34 I usually try to read all the references and things my teacher says we should.

Appendix C

Learning Process Questionnaire (cLPQ) Answer Sheet

Name______________________

Date________________________

Age_________ (Years & Months)

5 means . . . **Always** or **almost always** true of me
4 means . . . **Frequently** true of me
3 means . . . True of me about **half the time**
2 means . . . **Sometimes** true of me
1 means . . . **Never** or **only rarely** true of me

Place the number of your response to each question in the space in the table below.

Question	SM	DM	AM	SS	DS	AS
1						
2						
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34						

Appendix C

LPQ and R-2F-LPQ Questionnaire Comparison

LPQ	Wording Change	R-2F-LPQ	Item
1	x	11	Whether I like it or not, I can see that doing well in school is a good way to get a well paid job.
2	x	1	I find that at times studying makes me feel happy and satisfied
3			I try to obtain high marks in all my subjects because of the advantage this gives me in competing with others when I leave school.
4	x	12	I generally restrict my study to what is specifically set as I think it is unnecessary do anything extra.
5		6	I like constructing theories to fit odd things together.
6			I regularly take notes from suggested readings and put them with my class notes on a topic.
7	x	3	I am discouraged by a poor mark on a test and worry about how I will do on the next test.
8		17	I come to most classes with questions in mind that I want answered.
9			I have a strong desire to do best in all of my studies.
10	x	18	I learn some things by rote, going over and over them until I know them by heart even if I do not understand them.
11	x	10	I try to relate new material, as I am reading it, to what I already know on that topic.
12			I try to work solidly throughout the term and revise regularly when the examinations are close.
13	x	15	I intend to study to year 12 or beyond because I feel that I will then be able to get a better job.
14	x	5	I feel that nearly any topic can be highly interesting once you get into it.
15			I like the results of tests to be put up publicly so I can see by how much I beat some others in the class.
16	x	20	I find the best way to pass tests is to remember answers to likely questions
17 DS	x	21 DM	I like to do enough work on a topic so that I can form my own conclusions before I am satisfied.
18			I always try to do all of my assignments as soon as they are given to me.
19	x	7	Even when I have studied hard for a test, I worry that I may not be able to do well in it.
20	x	9	I work hard at my studies because I find the material interesting.
21			I would rather be highly successful in school even though this might make me unpopular with some of my class mates.

22	x	8	As long as I feel I am doing enough to pass tests, I devote as little time to studying as I can. There are many more interesting things to do.
23	x	2	I try to relate what I have learned in one subject to what I learn in other subjects.
24			Soon after a class or lab, I re-read my notes to make sure I can read them and understand them.
25 SM		16 SS	I find that it is not helpful to study topics in depth. You really don't need to know that much in order to get by in most topics.
26 DM		omitted	I feel that I might one day be able to change things in the world that I see now to be wrong.
27			I will work for top marks in a subject whether or not I like the subject.
28	x	22	I find I can get by in most common assessments by memorising key sections rather than trying to understand them.
29		14	When I read a textbook, I try to understand what the author means.
30			When a test is returned, I go over it carefully correcting all errors and trying to under stand why I made the original mistakes.
31 SM		omitted	I will continue my studies only for as long as necessary to get a good job.
32		19	I find that I am continually going over my school work in my mind at times like when I am on the bus, walking, or lying in bed, and so on.
33			I see doing well in school as a sort of game, and I play to win.
34	x	4	I see no point in learning material which is not likely to be in the test.
35 DS	x	13 DM	I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.
36			I usually try to read all the references and things my teacher says we should.

Appendix D

Internal Consistency Reliability (alpha coefficient) and Scale Independence (mean correlation of scale with other four scales) for ICEQ Scales-Long Forms

		Alpha coefficient				Mean correlation with other scales			
		Students		Teachers		Students		Teachers	
Scale	Unit of Analysis	Actual[a]	Preferred[b]	Actual[c]	Preferred[d]	Actual[a]	Preferred[b]	Actual[c]	Preferred[d]
Personalisation	Individual	0.79	0.74	0.79	0.74	0.28	0.31	0.32	0.29
	Class	0.90	0.86			0.31	0.35		
Participation	Individual	0.70	0.67	0.79	0.82	0.27	0.29	0.39	0.34
	Class	0.80	0.75			0.32	0.32		
Independence	Individual	0.68	0.70	0.83	0.86	0.07	0.12	0.23	0.25
	Class	0.78	0.79			0.16	0.17		
Investigation	Individual	0.71	0.75	0.80	0.90	0.21	0.27	0.34	0.33
	Class	0.77	0.83			0.29	0.31		
Differentiation	Individual	0.76	0.75	0.85	0.81	0.10	0.16	0.29	0.16
	Class	0.91	0.92			0.19	0.20		

[a]N, either 1849 students or 150 classes, according to unit of analysis

[b]N, either 1858 students or 150 classes, according to unit of analysis

[c]N, 90 teachers

[d]N, 34 teachers

(Fraser, 1990, p. 14)

Appendix E

Individualised Classroom Environment Questionnaire (rICEQ)

Preferred Classroom

How often would you like this to happen?

1 The teacher would consider students' feelings.

2 Students would discuss their work in class.

3 The teacher would decide where students sat.

4 Students would find out the answers to questions from textbooks rather than from practical investigations.

5 Students would work at their own speed.

6 The teacher would talk with each student.

7 The teacher would talk rather than listen.

8 Students would choose their partners for group work.

9 Students would draw conclusions from information.

10 All students would use the same resources for their class work and assignments.

11 The teacher would take a personal interest in each student.

12 Most students would take part in discussions.

13 Students would be told exactly how to do their work.

14 Students would carry out practical investigations to test ideas.

15 All students in the class would do the same work at the same time.

16 The teacher would go out of his/her way to help each student.

17 Students would give their opinions during discussions.

18 Students would decide on the distribution of work during group activities.

19 Students would find out the answers to questions and problems from the teacher rather than practical investigations.

20 Students would do different work according to their ability.

21 The teacher would be unfriendly to students.

22 The teacher would lecture without students asking or answering questions.

23 Students would have some choice in their assignment work.

24 Students would be asked to think about the evidence behind statements.

25 Students would work to different levels on assessments according to their ability

26 The teacher would help each student who was having trouble with the work.

27 Students would be asked questions.

28 Students would manage their own time on long term assignments.

29 Students would carry out practical investigations to answer their own questions

30 Students who finished their work would wait for the others to catch up.

31 The teacher would remain at the front of the class rather than moving about and talking with students.

32 Students would sit and listen to the teacher.

33 The teacher would decide which students should work together.

34 Students would explain the meaning of diagrams and graphs for themselves.

35 Each student would use different books, equipment and materials for assignments.

36 Students would be encouraged to be considerate of other people's ideas and feelings.

37 Students' ideas and suggestions would be used during classroom discussions.

38 Students would decide on the best way to make notes during class.

39 Students would carry out practical investigations to answer questions which puzzled them.

40 Students who worked faster than others would move on to something new.

41 The teacher would try to find out what each student wanted to learn about.

42 Students would ask the teacher questions.

43 Students would negotiate some parts of the assessment marking keys.

44 Practical investigations would be used to answer questions posed by the teacher.

45 The teacher would teach to the whole class using the same teaching aid (e.g. whiteboard or overhead projector).

46 The teacher would use assessments to find out where each student needed help.

47 There would be classroom discussion.

48 The teacher would decide how much movement and talk there should be in class.

49 Students would solve problems by obtaining information from many sources.

50 All students would be expected to do the same amount of work in the lesson.

Appendix E

rICEQ Answer Sheet

Name______________________

Date________________________ Year level_____________

Age ____________ ___________
Years Months

Note Question numbers go across the page in groups of five
Shade the box that corresponds to your response for each question

Key to responses
1 means . . . **almost never**
2 means . . . **sometimes**
3 means . . . **often**
4 means . . . **almost always**

Q	1	2	3	4	Q	1	2	3	4	Q	1	2	3	4	Q	1	2	3	4	Q	1	2	3	4	
1					11					21					31					41					Pe
2					12					22					32					42					Pa
3					13					23					33					43					Id
4					14					24					34					44					Iv
5					15					25					35					45					D
6					16					26					36					46					Pe
7					17					27					37					47					Pa
8					18					28					38					48					Id
9					19					29					39					49					Iv
10					20					30					40					50					D

Appendix F

Self-Efficacy Measure and Answer Sheet

		Agree			Disagree
1	I feel pleased with myself with what I learn in Science	1	2	3	4
2	I'm certain that I can master the skills taught in science this year	1	2	3	4
3	I can do even the hardest work in this science class if I try	1	2	3	4
4	If I have enough time, I can do a good job on all my science work	1	2	3	4
5	I can do almost all science work if I don't give up	1	2	3	4
6	Even if the science is hard I can learn it	1	2	3	4
7	I'm certain I can figure out how to do the most difficult science work	1	2	3	4

Appendix G

Interview Questions for Focus Groups

1. At the start of the year (Year 8) what did you hope science in High School would be like? (Preferred Classroom Environment)
2. What is science at High School actually like? (Actual Classroom Environment)
3. How do you know if you are doing well in science? (Assessment)
4. In science have comparisons been made between the achievements of different class members? If so give an example.
5. In science has feedback on assessments been designed to improve your learning as an individual? If so give an example. (Formative assessment)
6. Are you learning the skills in science you need to do well? (Efficacy)
7. Do the common assessment tasks affect the way your teacher teaches you? (Actual Classroom Environment)
8. Have you ever made a conscious decision to work harder on one science assessment compared to another? If so why? (Assessment and SRL)
9. Do you think your preferred classroom environment has changed since starting at this school? If so, why do you think this is? (Preferred Classroom Environment)

Appendix H

List of Artefacts

Artefacts collected from the G&T class of the GTSP 2007

1. 3 CAT's Term1, 2 and 4
2. End of topic test Term1
3. Examinations Semester 1 and 2
4. Drafts for authentic task on green energy (from one-on-one interviews)
5. Concept map Photosynthesis Term 4
6. Science Investigations Term 3 Term 4
7. Creative writing circuits Term 1
8. Hairy sheet (spider chart) Term 1
9. Fishbone-circuits Term 1
10. Satisfaction Poll
11. Selected note taking sheets Term 1 (visuals only)
12. Note taking, dictagloss Term 4
13. Quiz questions based on Bloom's taxonomy - Circuit board
14. Essay Term 4
15. HAST results Year 8
16. Student results Year 8 level grade and rank
17. Student results Year 9 level grade and rank
18. MSE results Year 9
19. International testing ICAS Science Competition
20. Australian National Chemistry Quiz results
21. WESTPAC Maths results

Appendix I

Interview A: Protocol

Interview A protocol about student preparation for the common assessment task.

1. How did you go about preparing for the common assessment task?

2. Did any of the following strategies help with the common assessment task: fishbone, concept map, Bloom's taxonomy questions, hairy sheet (spider diagram), metacognitive sheet, analogy -role play, revision sheets?

3. Further questions asked to tease out self-regulation strategies used based on Zimmerman's classification scheme

Category of SRL strategy	Examples
Self-evaluating	Check quality of own work
Organising/transforming	Rearrangement of instructional materials, analogies, cognitive organisers
Goal setting/ planning	Goals, sub-goals, timeline
Seeking information	
Keeping records, monitoring	Note taking, summarising
Environmental structuring	Study area etc
Self-consequating	Self-rewards or punishments
Rehearsing, memorising	
Seeking assistance: peers, teachers, adults	Explaining to someone else, asking questions, answering questions
Reviewing records: notes, tests, textbooks	Highlighting, paraphrasing
Other	Responses about behaviours instigated by others (not SRL) or other (unclear)

Appendix J

Interview B: Hypothetical Task

You have received a flier from school about choosing green energy at home. You want to help the environment, but you are not the one paying the electricity bills!

You are planning to talk to mum and dad at dinner time later in the week about switching to green energy, but you need an action plan. You are also going to take something in writing to the dinner table.

Draft the action plan and the written work that you will use when you discuss the issue with your parents.

Note: with this task a flier and information sheet were provided for student reference purposes.

Appendix K

Information Letter

Study of the Gifted and Talented Program

February 2007

Dear parent/student

In 2006 I began research to examine learning strategies of Year 8 Gifted and Talented students. Initial analysis of the data collected indicates that student learning strategies are affected by many factors including classroom teaching and assessment practices. To examine this area further I have extended my study towards a PhD in Education. Ultimately I hope my research will lead to improvements in Gifted and Talented education at MHS and throughout Australia. This research has been approved by the Edith Cowan University Human Research Ethics Committee.

During the course of 2007 I will be participating in your child's Science classes, making observations, talking with Gifted and Talented students and from time to time making copies of student work to assist my analysis (all original work samples will be promptly returned).

Students in the Gifted and Talented class will complete two surveys during Science (each takes about 20 mins). Statistical analysis and conclusions will be shared with the teacher and used to assist in the selection of improved teaching strategies. The statistics and conclusions will form part of my research thesis. The identity of students will be kept confidential in any printed material I submit as part of my research. The school and individual students will be anonymous in any future publications. On completion of my research individual surveys will be destroyed.

If you do not wish your child to participate in the surveys, please sign the form over the page and return to Ms X at school.

If you have any further questions please do not hesitate to see me at school or contact my PhD supervisor at Edith Cowan University.

Contact details provided

I **do not** wish my child (name)____________________to complete the written survey.

Name of Parent___________________________

Signature____________________________________

Appendix K

Study of the Gifted and Talented Program

Consent to One-on-One Interview

February 2007

Dear parent

Thank you for allowing your child to participate in the recent survey relating to the learning strategies of Gifted and Talented students. Ultimately I hope my research towards a PhD in Education will lead to improvements in Gifted and Talented (G&T) education at MHS and throughout Australia. This research has been approved by the Edith Cowan University Human Research Ethics Committee.

To further my study I would like your son/daughter to participate in a one-on-one interview (approximately 30 mins) that will be audio-taped towards the end of the term during school time (ideally during a science period). In the interview, I will ask questions concerning student approach to learning and assessment. The interview will provide valuable research data not accessible by survey methods, so I hope you will agree to your child being interviewed. I am sending this letter to only 12 Year 9 G&T students in the hope that they will all participate.

The audiotape will be transcribed and analysed. Pseudonyms will be used when the data are reported so that no individual student or school can be identified. Audiotapes will be stored securely and destroyed five years after completion of the study.

If you agree to allow your child to participate please complete the consent form attached and return it to Ms X at school by **Friday 1st March 2007.** Your child is free to choose not to participate in the interview or answer individual questions. If your child agrees to participate they are required to sign the participant consent form attached.

If you have any further questions please do not hesitate to see me at school or contact my PhD supervisor at Edith Cowan University.

Contact details provided

Appendix K

One-on-One Interview

Informed Consent Document (Participant)

I _______________________ (PRINT STUDENT NAME)

- have been provided with a participant information letter explaining the study
- have read and understood the information
- have been given an opportunity to ask questions and have had any questions answered to my satisfaction
- am aware that I can ask further questions at any time
- am aware that participation will involve my being audio taped
- understand that the information provided will be kept confidential and my identity and the identity of my parent/guardian will not be disclosed without consent
- understand that I am free to withdraw from further participation or I may withdraw from participation at any time without explanation or penalty
- freely agree to participate in the study

Signed by student_______________________________

Date__________________________________

Appendix L

Sample Program Energy and Change

STUDENT OUTLINE
MHS YEAR 9 PROGRAM -
TERM 1
ENERGY AND CHANGE

NOTE
- *Order and timing of content may vary slightly from the program.*
- *Timing of test may vary slightly from that in the program.*

Week	Content / Outcomes	Text Reference **Jacaranda Book 2**
1	Static Electricity	10.7 p238-239
	"Electricity in the Round" Current and Voltage	10.1 p 226, 227
	"A Current Affair" Conductors and Insulators. Measuring current Amperes	1 0.2 p 228-229
2	"A light in the Dark" Cells in Series. Circuit Diagrams	1 0.4 p 232-233
	"Series and Parallel" Circuit Types and Diagrams	10.5 p234-235
3	"Electrical Quantities" Current Voltage and Resistance	11.1 p248-249
4	"Electricity at home"	11.4 p254-255
	Energy measurement. Energy units and conversions	11.5 p256-257
	Review and Consolidation for Common Assessment Task	P242-243 P 262- 263
5	Energy sources Renewable non-renewable sources	
6	Potential energy Kinetic energy Potential energy calculations Kinetic energy calculations	
7-8	Open Ended Investigation Investigating Scientifically	
9	Review and Consolidation **Test**	

ASSESSMENT
During the term all year 9s will have:
One test and One Common Assessment Task
Each teacher will set additional assessments and homework tasks.
Year 9s will have about 2hrs of Science homework a week.
Investigations will be used to assess the Investigating Scientifically Strand.